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the OIL AND GAS JOURNAL

OVEMBER 26
1942

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WORTH KNOWING
WORTH SHOWING!

NO BRANCH of the United States Army performs a more humanitarian and necessary service than the Nurse Corps. In hospitals, camps and posts, at home and abroad, they provide nursing care for the men of the Army. As members of the medical unit, attached to all divisions, they go into combat zones administering to the wounded with complete unselfishness and tireless energy.

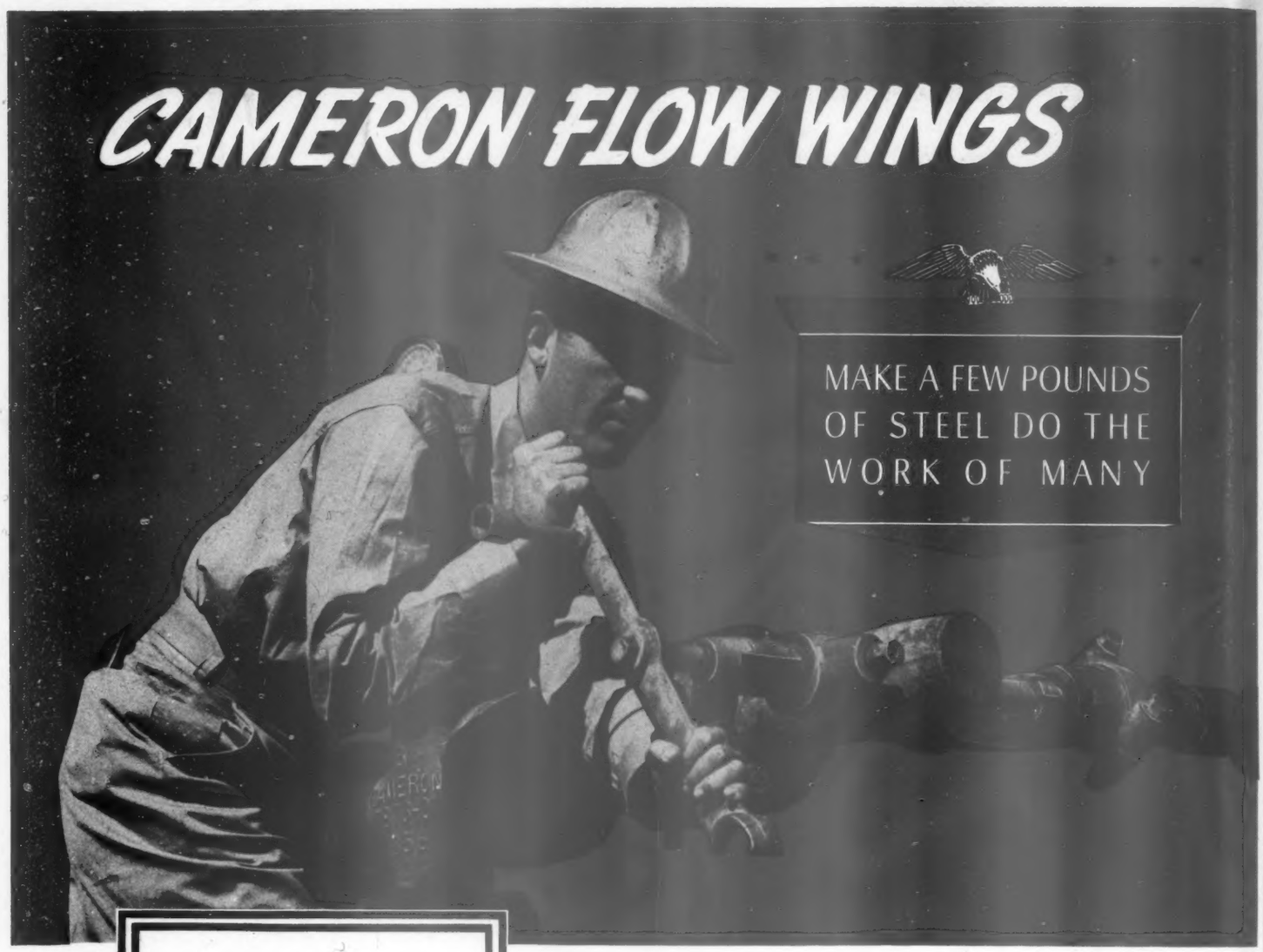
Members of the Corps are called from the First Reserve of the Red Cross Nursing Service and any other acceptable source. The First Reserve is composed of registered nurses who have signified their willingness to serve with the Army or Navy Corps, and who are physically and professionally qualified to meet the requirements.

Upon entering the Corps, Nurses receive relative rank as Second Lieutenants. The Superintendent of the Corps is a Colonel; her first assistant, Lt. Colonel; her second assistant holds relative rank as a Captain; Chief Nurses have the relative rank of First Lieutenant. Their rank corresponds to, and they wear the same insignia in the same manner, as commissioned officers in the Army. The special Corps insignia is the Medical Corps caduceus with the letter N. It is worn on each lapel of their dress uniforms.

Nurses may enlist for periods of three years, or in wartime they may enroll for the duration and six months.

HUGHES TOOL COMPANY
HOUSTON, TEXAS

CAMERON FLOW WINGS



Cross-section view of a Cameron Type "D" Flow Wing

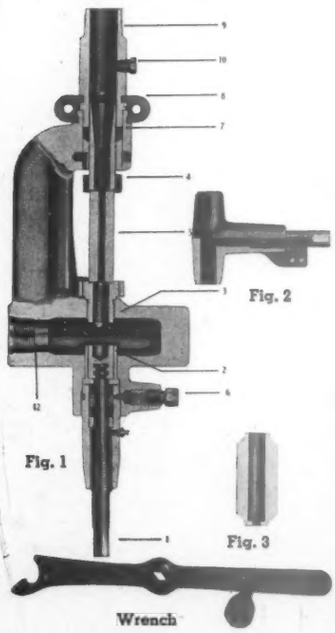


Fig. 1

Fig. 2

Fig. 3

Wrench

In keeping with the spirit of the times, Cameron urges production men to consider Cameron Flow Wings as a safe means for saving critical steel on Xmas tree manifolds. Four essential Xmas tree fittings are combined in this single compact unit: (1) An efficient wing valve that closes easily under full rated pressure; (2) A quick-change positive or adjustable choke, as desired; (3) An efficient 2-bolt flowline union that obviates the need for an additional union in the flowline; and (4) A bleeder plug to release pressure trapped in the flowline.

Easy to Operate

Referring to Figure 1 at left, to change flow bean fit hexagon socket in wrench to valve stem (1) and close valve (2) against seat (3). Spanner part of wrench is then applied to clamp screw (4), and only two turns required to release flow bean (5). New bean is clamped in place by clamp screw and valve is then opened and well is back on production. Both valve steam and valve seat are faced with hard metal to resist cutting. Valve stem and bonnet are packed with plastic packing which may be replenished under pressure. Clamp screw is packed with an asbestos ring (7) which is tightened automatically as flow bean is clamped in place. Two-bolt union (8) obviates need for additional union in flow line. Note that downstream end of clamp screw is belled to reduce turbulence and cutting. Three types of flow beans are interchangeable: (1) "Proration" bean illustrated in flow wing; (2) adjustable flow bean, Figure 2; and (3) "production" type bean which consists of a body and renewable stellite orifice disc. All flow beans clamp in position as shown in Figure 1.

Cameron Type "D" Flow Wings are offered in several screwed and flanged styles, ranging up to 10,000 lb. test. Like any standard fitting or valve, they may be incorporated in any manufacturer's Xmas tree.

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Oil Drilling
Material Cut
50 Per Cent
WASHINGTON, Nov. 11.—Oil producers probably will receive no more than 50 per cent of their normal material requirements during 1943, Don R. Knowlton of the Office of Petroleum Co-ordinator in Washington declared in an address before the American Petroleum Institute in Chicago Wednesday.

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SEISMOGRAPH SURVEYS

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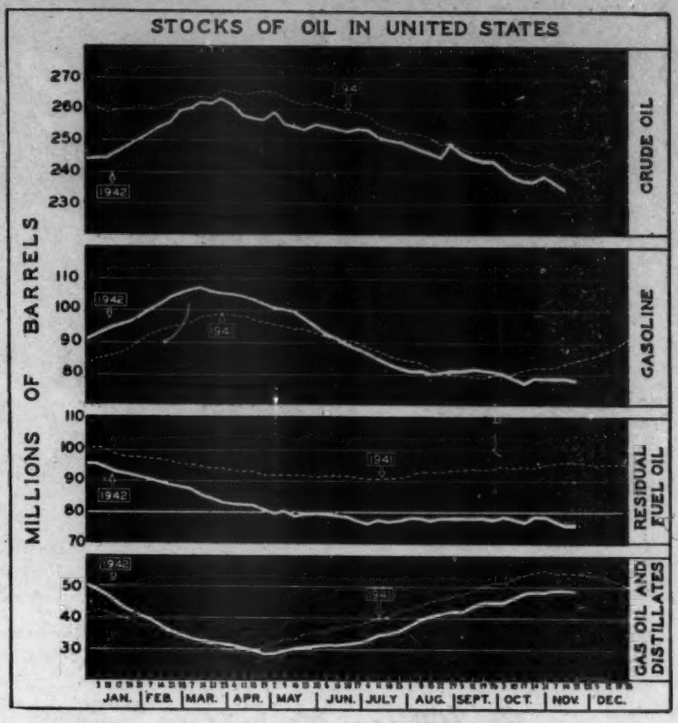
Trends

Eastern Shortage Will Require an Immediate Remedy



HOW to get from 150,000 to 200,000 bbl. daily more crude oil and products to the eastern part of the United States is the most pressing problem of the oil industry, according to representatives of the industry and the war agencies, this need overshadowing in immediate importance the national rationing of gasoline which becomes effective next Tuesday. The situation in regard to eastern oil supplies was called to the attention of the industry at the recent A.P.I. and PIWC meetings in Chicago, and conditions have since become more critical due to the increased demands at Atlantic seaboard and Gulf Coast terminals and refineries as a result of the Allied North African campaign.

CRUDE PRODUCTION *3,915,825 bbl. daily average—up 35,225 bbl. One year ago 4,329,365 bbl.*

CRUDE STOCKS *235,262,000 bbl. as of Nov. 14—down 936,000 bbl. One year ago 240,399,000 bbl.*

GASOLINE STOCKS *78,583,000 bbl. as of Nov. 21—down 835,000 bbl. One year ago 83,683,000 bbl.*

RESIDUAL FUEL-OIL STOCKS *77,779,000 bbl. as of Nov. 21—down 852,000 bbl. One year ago 94,972,000 bbl.*

GAS OIL AND DISTILLATES *49,541,000 bbl. as of Nov. 21 — down 320,000 bbl. One year ago 56,380,000 bbl.*

REFINERY RUNS *3,722,000 bbl. daily week ended Nov. 21—down 66,000 bbl. One year ago 4,054,000 bbl.*

Analyses that have been made of transportation conditions to the East Coast are in agreement that tank-car shipments of around 750,000 bbl. daily are all that should be expected through the coming winter months. This figure takes into consideration the improved transportation situation which will develop after the 24-in. line from East Texas to Illinois is in operation early next year.

The latest action to improve eastern conditions was to reduce the A gasoline ration unit from 4 to 3 gal. It is also stated that restrictions in the issuance of B, C, and S-type books will be tightened. The objective of this program is to reduce the gasoline shipments to the East in order to provide more tank cars for the movement of the heavier oils. It is agreed that the reduction of the A coupons to 3 gal. per week represents the minimum allowance that can be made effective without seriously affecting civilian transportation and war production operations in the East.

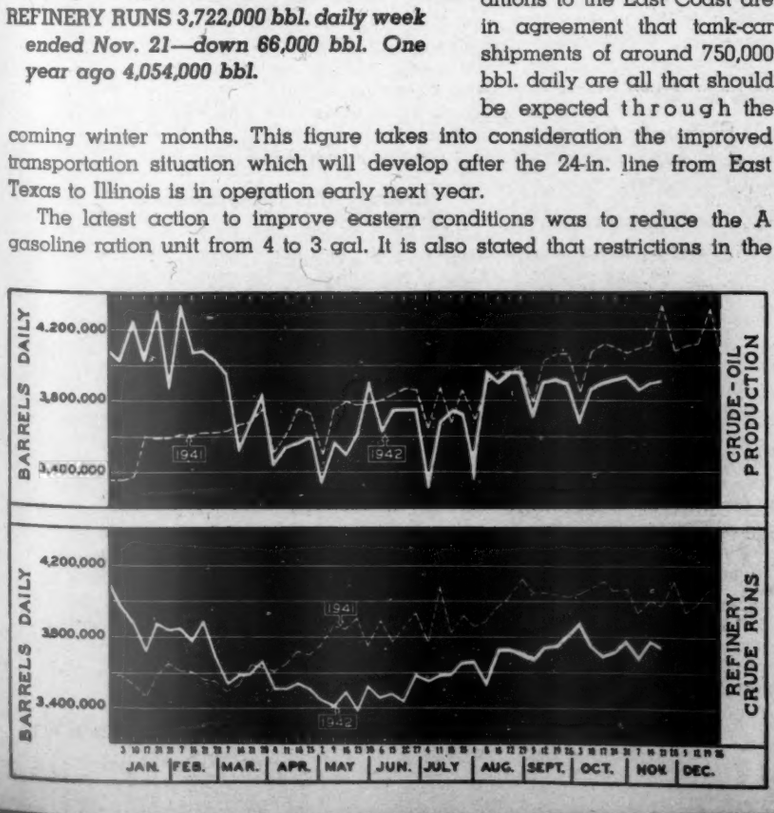
Taking these and other minor aids into consideration, surveys show that eastern supplies are around 100,000 bbl. daily short at this time with the shortage to expand because of additional demands assured for December and the early part of 1943. These analyses assume, of course, a continuance of the small tanker movement from the Gulf.

Statistically the eastern supply situation has not changed greatly over the past month. Current reports combine East Coast, Gulf Coast, Inland Texas, and North Louisiana-Arkansas refinery operations. The East and Gulf Coast plants account for approximately 85 per cent of the total. For the entire area, crude runs to stills are 15 per cent less than a year ago and gasoline production has decreased 22 per cent. Stocks of gasoline are 8 per cent greater than they were in mid-November 1941, but stocks of gas oil and distillate are 13.5 per cent less and inventories of residual fuel oils have decreased 23.5 per cent.

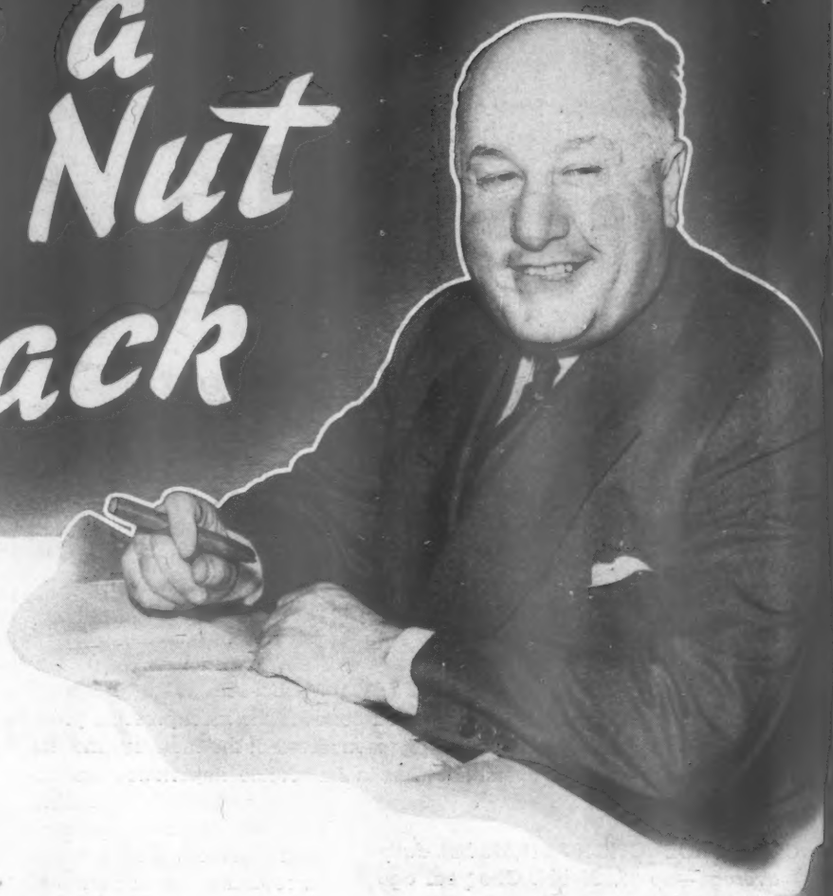
DAILY AVERAGE PRODUCTION FOR WEEK

	Nov. 21 crude oil	Nov. OPC quota all oils	Nov. 14 crude oil
Arkansas	74,000	77,200	74,000
California	739,750	782,000	742,250
Colorado	6,565	7,000	6,465
Eastern fields	92,700	105,200	90,550
Illinois	263,500	280,900	236,000
Indiana	15,550	18,400	18,150
Kansas	311,550	200,700	305,950
Louisiana	325,400	333,800	323,800
North Louisiana	*96,700*	.....	*96,100*
Louisiana Gulf Coast	*228,700*	.....	*227,700*
Michigan	61,880	64,500	65,500
Mississippi	64,500	50,000	67,100
Montana	22,420	24,800	21,820
Nebraska	3,150	3,400	3,400
New Mexico	101,460	100,600	101,450
Oklahoma	363,300	407,500	358,950
Texas	1,376,450	1,381,000	1,373,250
East Texas	*354,800*	.....	*354,800*
West Texas	*212,500*	.....	*211,800*
North Central Texas	*137,600*	.....	*137,600*
East Central Texas	*95,600*	.....	*95,100*
Texas Panhandle	*89,800*	.....	*89,800*
Texas Gulf Coast	*415,800*	.....	*413,900*
Southwest Texas	*70,350*	.....	*70,250*
Wyoming	93,650	94,400	91,965
Total United States	3,915,825	4,031,400	3,880,600

Total production, January 1-November 21, 1942..... 1,237,248,000 bbl.
Same period last year ..... 1,235,486,945 bbl.
Texas shutdown days, November 15, 21; previous week, 8, 14.



We Have a Tough Nut To Crack



By William M. Jeffers

National Rubber Director

(An exclusive statement to The Oil and Gas Journal)

WE have a tough nut to crack. That "nut" is to keep America on wheels. The job extends from the production line to the front line; from the farmer taking his produce to market to our soldiers racing across North Africa. It's the biggest job we, the people of the United States, ever tackled and it places on you of the petroleum industry a grave responsibility.

Your responsibility is twofold. You have been called upon to make large quantities of synthetic rubber, to build a great industry from the pilot-plant stage to full-throttle production in a couple of years. That's a man-sized task. While we are waiting for synthetic rubber, the motor vehicles of the United States must be kept rolling and the needs of our armed forces met with the rubber we have. The petroleum industry must take a leading part in that program.

Must Team Together

Those jobs are big enough to challenge the combined imaginations and ingenuity of every oil man. To accomplish them we must work together as a production team, oblivious of every other consideration. We must worry as little about what will happen "after the war" as do the soldiers on the battlefield. Only by that kind of an effort will we keep America on wheels, the wheels she must have to win the war.

I am expressing no view as to whether or not synthetic rubber will replace crude rubber after the war. I am not concerned whether its base be alcohol, oil or whatnot. I do know that we must have the best synthetic rubber we can make, in the largest quantities we can make it, at the earliest possible date, to win the war.

This calls for a complete pooling of information and experience in the making of synthetic rubber. It is a pioneering job, the charting of a new course in the higher reaches of chemical and engineering research. Under our normal economy we depend upon competition to provide these answers. Today we do not have time to wait for that. Each new development must be quickly transmitted to everyone else. Teamwork of a high order is called for to avert this critical threat to our entire war effort. We are going to have that teamwork.

The threat to the nation's war effort by lack of rubber is a very real and vital one. We depend upon rubber-borne transportation to an extent not equaled elsewhere in the world. Any appreciable decline in transportation would be immediately followed by a decline in our output of the instruments of war. If any considerable proportion of the 85 per cent of the workers in war factories who now travel to work and back in private cars were unable to do so the results would be apparent in a short time.

We cannot turn to public transportation facilities to carry the load. We cannot turn back the clock. The development of motor vehicles in this country in the past 20 years is such that we are going to have to run on tires or stop running.

There are a million tons of rubber in the tires of our cars and trucks now on the road. Those tires are going to have to last 2 years instead of 1. They are our main resource and the only hope we have to bridge the gap between now and the time in 1944 when synthetic-rubber production reaches its peak.

The only way to make them last is to reduce our driving by half. As some driving is necessary, and some drivers must travel long distances, the Baruch report recommended that all driving be eliminated except essential driving.

The device recommended in the Baruch report to accomplish this is rationing of gasoline and that is the device I have adopted. This is not gasoline rationing to conserve gasoline, of which, except in the East, we have a plentiful supply. It is mileage rationing to conserve rubber. There is no other purpose. When the times comes that we have enough rubber to permit relaxation of rationing I will be happy to so order.

Because some tires are going to wear out in spite of strict rationing and careful conservation, we have taken a number of steps to bolster our tire supply. These are the manufacture of retreading material out of reclaimed rubber, manufacture of a number of tires from reclaimed rubber, and purchase of all tires over five owned by the motorists of the United States. All of these combined, however, constitute only a bolster and will serve for necessary replacements only. They will, I think, permit us to bridge the gap without serious transportation difficulties, provided extreme care is taken in tire conservation.

Industry Has Close Contacts

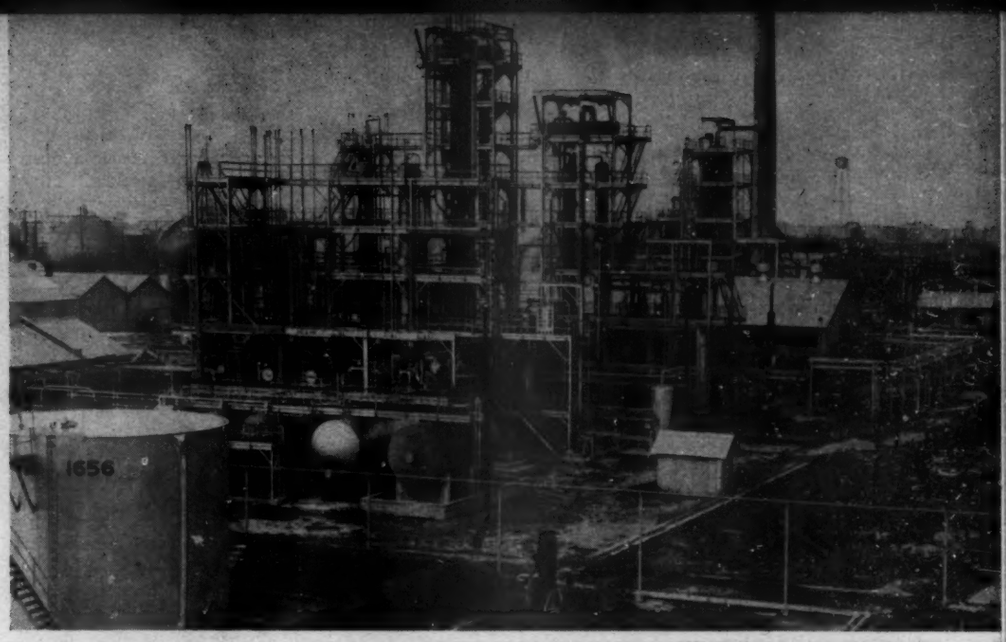
Your industry has the closest of possible contacts with the motorists of the United States. Your outlets are the ones that will help conserve these tires. I ask your help in keeping the basic facts about the rubber situation before the American people so they will know why mileage rationing and rubber conservation are so all-important.

I have great faith in the American people. I believe they are willing to make any personal sacrifice to help win the war, if they know why that sacrifice is necessary. The sacrifice of driving as usual is necessary so we can have tires for essential driving not only this year but next.

As I said in the beginning, the petroleum industry has a grave responsibility. In the light of its past achievements I am confident it will measure up to this one.

Faced with the most damaging shortage of a critical material in our history American industry, science, technology and ingenuity are proving capable of making a reality of the seemingly impossible. Following the near-chaos of the earlier months of this year a rounded, well-organized plan for getting the job done is functioning satisfactorily.

By HENRY D. RALPH
and ARCH L. FOSTER



All over the United States rubber intermediate plants like this are taking shape at an accelerated rate as the synthetic-rubber program moves into "high" to supply military and civilian needs. This unit is one of the earlier ones

New Billion-Dollar Rubber Industry In the Making

THE United States is making its own rubber. A brand new, billion-dollar industry, if present schedules are carried out, will be in full operation a year from now turning out all the rubber we need—2 billion pounds per year, worth at 1941 prices a half billion dollars.

In the meantime we will have enough rubber of various kinds, natural and man-made, to fight a war across two oceans and to maintain, with some pinching, our essential civilian economy.

A year ago December 7 Japan launched an attempt to occupy all of the world's commercial rubber-producing areas and to cut the United States off completely from this essential commodity of war, industry, and transportation. She succeeded to the extent of 90 per cent of it.

Today we know with complete confidence that we will not lose the war for lack of rubber. Furthermore, our war program, either on the battlefields or on the home front, will not be fatally hampered or delayed by the transition from an importing to a self-sufficient nation with regard to rubber. Our trucks and buses and even most of our passenger automobiles will be kept on the road, on rubber tires, though during 1943 their use will be limited to essential travel.

This achievement is a triumph of chemistry, engineering, and statesmanship. There were mistakes and delays, confusion and conflict, but they are mostly behind us. Today we have a definite program and are started on its fulfillment. Our goals are both sufficient to meet our needs and attainable within the coming year. We know how much rubber we are going to make, what processes we shall use, what and where the raw materials are.

We have a goal of a half million tons of synthetic rubber in 1943. We will make at least a million tons of various kinds of synthetic rubbers in 1944, possibly considerably more. With these amounts we can fight the war and keep tires on the wheels of our automotive equipment.

And we have adequate supplies but no surpluses of natural rubber. Our crude-rubber stockpile can, with miserly use, be made to last until there is enough synthetic to take its place. We are still getting important quantities from the Orient, more than seemed probable last spring, and welcome trickles are flowing from South and Central America. This helps us through a tight period, brightens our outlook for the future, and will fill in any deficiencies which may develop in synthetic rubber, either qualitative or quantitative, through mixing with synthetics or for specialty uses for which synthetics may prove inferior.

The year 1943—say the next 10 to 15 months—will be the critical period. It is not as critical as it appeared last summer. During next year the big synthetic-rubber plants and the plants making the ingredients for them will be coming into production, and while their output is scheduled to reach the top rate by the end of '43, actual production for the year as a whole will be somewhat less than our consumption and our stockpile will be reduced to an uncomfortably low figure. We are gambling on the synthetic industry, but it is a pretty safe gamble.

For the motorist there is assurance that he can get some kind of tires—poor when compared with quality standards of recent years, but tires—provided his car is used only for essential pur-

Five-foot, 200-lb. "boots" for Uncle Sam's air fighters require large quantities of rubber. This stack of tires will supply a hundred Flying Fortresses

poses. During the next year he will have to get along on recapped old tires and tires made of reclaimed rubber and of synthetics with wearing qualities inferior to natural rubber. But by some time in 1944 America's cars should be well shod entirely with test-tube-developed rubber.

Intermediates From the Oil Industry

The oil industry's part in this new war-born synthetic-rubber industry is to supply the lion's share of the important ingredients for the synthesis plants, particularly two-thirds or more of the butadiene which is the principal ingredient of buna-S rubber, the "tire rubber" which forms the bulk of the program.

At the start, production of butadiene was the bottleneck. It is no longer. Several processes are being used with every prospect of success, some plants are already in production, and construction of rest is proceeding with all possible speed.

Synthetic rubber is not entirely the child of the petroleum-refining industry. The chemical industry and the rubber-goods-manufacturing industry have equal shares in it. The best technical brains of all three have gone into its development.

To indicate more definitely the progress which has been made and which may be expected with confidence within the next year in manufacture of butadiene, plans call for completion of the following total capacities, which will be in operation on or before the dates given:

Date—	Capacity (tons)
September 1942	13,300
January 1943	22,800
March 1943	227,800
June 1943	522,800
October 1943	667,800

Completion of the styrene program aggregating more than 200,300 short tons is expected on or before the completion of the butadiene program.

Synthetic rubber is really a government industry, the only government-owned basic industry in our history. This not through socialistic intent, but because it is—at present—a war industry. Private industry could not risk the tremendous sums of money—a billion dollars—in unproved plants and processes. Private business could not force the pooling of patents and technical skills, nor would antitrust law permit it to do so. Nor could private industry do all the other collaborative things to push the huge program through in a hurry. The Government owns title to all the plants (except a few small ones integrated with other equipment or started privately before the war). It buys the raw materials, directs shipments, processes and production rates, and owns the completed rubber. Commercial concerns participating are only contracting agents of the Government, to carry out the required research and the manufacturing operations.

After the war the plants will be for sale, with the present operating agents having an option. Then, according to present plans and contracts, those plants giving promise of further value will pass into the hands of private industry. The government plan is to pass out of the rubber-making business after the war, writing off as a war cost its investment in plants and processes which may not prove economically sound in peacetime.

For this new synthetic-rubber industry is not just a "war baby" which will languish after the armistice. It is here to stay. New processes will be developed and present plants will become obsolete, capacity may exceed demand, but these new synthetic rubbers will be so good and so economical—pound for pound and dollar for dollar—that they probably will replace natural rubber permanently for most, if not all, uses. This is the prediction of many of the country's leading rubber technologists and their forecast is justified by the speed of the progress they have made during the last 10 months in developing improved methods of synthesizing the stuff and adapting it to various uses.

Synthetic's Advantages

The two great advantages of synthetic over natural rubber are for us, that it can be produced entirely within our own borders, and that its properties and special uses can be varied over a much wider range than natural rubber can possibly be made. Synthetic rubbers are not composed of merely a specific molecule; they are made up of several different molecular products; these can be combined in different proportions to make essentially different materials, each possessing rubber-like properties. Different unit materials may be copolymerized to produce rubbers so different in important characteristics that these variations fit rubber for a new and broader function in our postwar civilization. It is this opportunity to produce "tailor-made to order" rubber that constitutes the synthetic's chief superiority, an advantage which no rubber chemist has been able to perfect equivalently in natural rubber.

We realize that not all the hurdles have been surmounted yet. Once the plants are completed and operating, the technique of production must be mastered. "Bugs" appear in every new process and plant, no matter how well known the principles of the process are. These must be

worked out by trial and error, variations in methods are necessary even in individual plants using the same identical process. Staffs must be trained to a fine degree of efficiency; test and control methods must be perfected. But the chemists and the engineers know mostly where the troubles will come, know how to anticipate them in good measure and how to tackle them when new ones show up.

One of the serious problems for technologists to solve more completely is the more efficient concentration of intermediates, especially butadiene, to higher degrees of purity, and the elimination of impurities which interfere with later processing. Excellent methods are used now for accomplishing these steps, but some require more critical materials and more expense than do others, especially for facilitating the most rapid progress. These processes will be perfected rapidly, and as time goes on critical materials will become less critical—more steel will be available, equipment will be made faster.

Requires More Milling Capacity

A second problem well on its way to rather complete solution is that of the specific properties of synthetic rubber which differ from those of the natural material, as they affect processing to the finished goods. Synthetic rubber is stiffer, harder than natural; requires more "working" or milling to break it down to a condition which permits perfect blending, fabrication and finishing. This means a greater milling capacity per thousand tons of rubber, a capacity which is being built into the new plants by wise forethought. One-third more milling capacity is required for synthetic than for natural rubber. The important point is that we know how to condition this stiffer rubber to get the kind we need.

Fortunately most of the special chemicals required for finishing natural rubber do a good job on synthetic; especially good new chemicals have been discovered which in some cases do a much better job on the synthetic product, give it superior qualities. Enough of its special technology is understood to enable the chemist-engineer fraternity to predict and to direct intelligently the course of research to speed the perfection of process and product.

That the program for rubber synthesis in 1943 is heartening in view of the rapid strides now being made after all these months of confusion, divided authority and conflicting ideas is indicated by the 425,000 long tons which, barring unexpectable catastrophe, will be added to our stock pile next year. From this, the Baruch committee estimated that 263,000 tons of natural and synthetic rubber will be available for civilians' necessary uses, plus 106,000 tons of reclaim, a total of 369,000 tons of three-fifths or our normal prewar consumption over-all. The critical imperativeness of pushing the program along on schedule, "bulling the program through" as that committee forcefully stated it, is clear and patent to every man working in the industry and it will be an insurmountable obstacle indeed which will slow down the advance appreciably.

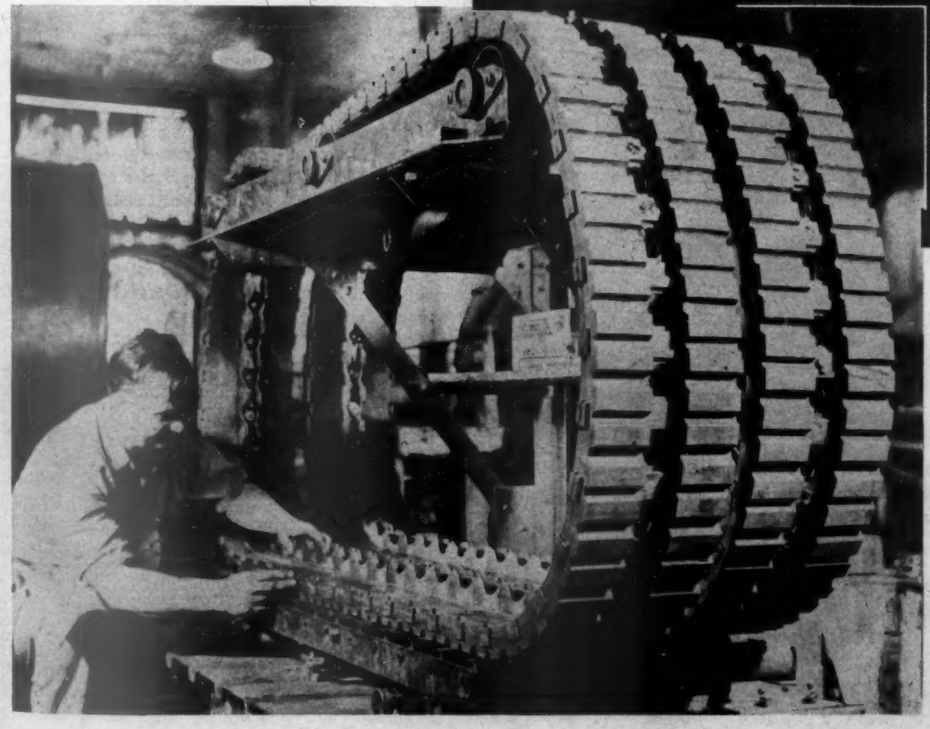
The minimum total production in 1943 is 516,000 tons, nearly as much as was used in this country before the war (1941). By early 1944 we shall be synthesizing rubber at the rate of 1,106,000 long tons annually, more than we expect to need. But we must supply our Allies' needs by an undisclosed but considerable amount. A reasonable estimate indicates that this program will cost us nearly a thousand dollars for each ton of annual capacity put into operation—to fail to start it operating will cost us our civilization.

Among our brighter spots is that of an adequate supply of raw materials from several sources for the production of butadiene and styrene, the tire-rubber intermediates. Some 400,000 bbl. per day of butanes and butenes are available potentially in this country; about half of this amount is described as "readily" available, or nearly 200,000 bbl. per day. The total estimated needs for raw stock to produce our butadiene requirements range from 50,000 to 65,000 bbl. per day, leaving plenty of easily procurable butane for aviation gasoline synthesis and for other essential purposes. Also, butadiene can be produced from naphtha or gas oil, both of which we have huge overpulses; from alcohol, ethyl or butyl, or from butylene glycol, all producible from natural or refinery gases or from grains. From the waste lignin — carbohydrate — material from paper-pulp making it has been estimated that 900,000 tons of butadiene, more than our whole requirement now, can be made as easily as from grain alcohol.

Little Nontire Rubber Made

No preparations have been made to produce specialty rubbers of the buna-N type, other than the 60,000 tons of neoprene and approximately the same amount of thiokol suggested by the Baruch committee. Both these quotas are for either ersatz production, because of the existence of output capacity from peacetime operations, or for special purposes such as oil-resistant rubber, insulating rubber, or similar applications required by the military and naval services. Most of this neoprene and thiokol rubber will be used to recap used tires.

No provision has been made for such nontire rubber for civilian, commercial, or industrial purposes because such is not indispensable for war prosecution. The plant capacity, which was producing 15,000 to 20,000 tons annually before the war, will be expanded to make additional amounts needed for the armed forces. Butyl rubber is obviously an admittedly substitute material for the war period, because of its relative ease and rapidity of manufacture. It is considered especially useful for certain industrial applications and will find its uses after the war. Flexon will not be made because of its waste of intermediates.



Petroleum Rubber Program Progressing Satisfactorily

Progress on the synthetic-rubber program gives promise of its being completed ahead of schedule which expects to have all capacity operating by late 1943. The critical period will be 1943; strict conservation will get us by with a small but safe margin

By HENRY D. RALPH

STARTING from negligible quantities a year ago, the United States will produce half a million tons of synthetic rubber in 1943, and a million tons in 1944. These figures are conservative and may well be exceeded, particularly the 1943 figure.

A million tons of rubber is about all the entire world used in a normal prewar year. A half million tons is almost as much rubber as the United States used in a normal prewar year; it is also nearly as much as our estimated military, essential civilian, and United Nations export demands (but not including passenger-car tires) for 1943. The 1944 anticipated output is comfortably above all estimated requirements, including civilians' tires as well as military needs, for that year.

After 1944, therefore, this country should have synthetic rubber to fill all needs (to say nothing of the anticipated deliveries of natural rubber which we hope to obtain, in uncertain but important quantities, from South and Central America, Africa, the Orient, and from domestic guayule and similar plants). But 1943 is the critical year, for during most of that time our stock pile of crude rubber will be diminishing at a much faster rate than our production of synthetic, and along about next fall the margin of safety may be rather slim.

For that reason the rubber director and his staff and the federal agencies under his direction are bending every effort to increase production next year, and are not at present giving much thought to the program for 1944 and beyond. They are making no promises, but they have every expectation of seeing at least 400,000 tons of buna-S (tire) rubber produced in 1943 plus around 100,000 tons of the specialty rubbers neoprene, butyl, and thiokol. There are indications that actual production, particularly of buna-S, will be considerably above that.

The present program, in long tons, is shown in the following tabulation.

Type—	Minimum production in 1943	Capacity under contract	Probable expansion	Total
Buna-S	400,000	705,000	140,000	845,000
Neoprene	30,000	69,000	.....	69,000
Butyl	62,000	132,000	.....	132,000
Thiokol	24,000	60,000	.....	60,000
Total	516,000	956,000	140,000	1,106,000

These estimates are all in round figures, or, as the engineers say, plus-or-minus, for no one can tell exactly how much a plant will produce until it gets into operation. After a new plant of any kind has been broken in it usually is capable of producing more than the rated capacity assigned it by its designing engineers.

The capacity under contract is all scheduled to be completed by the fall of 1943, so that the maximum production rate should be reached easily by January 1, 1944. The probable expansion of 140,000 tons capacity for buna-S production was recommended by the Baruch committee but has not yet been placed under contract. The reason for this is that 30,000 tons of this capacity is purposely being reserved for a few months to study promising new processes, and it was felt to be pointless to contract for the other 110,000 tons immediately because work could not be started on fabrication of the equipment until some of the other plants are completed. However, there is every intention to add this additional 140,000 tons to the program in the relatively near future, and it very likely will be completed by the end of 1943.

Entire Program Government Financed

Except for a few small privately owned plants in operation or under construction before Pearl Harbor, this entire new industry is a government project, financed, owned, and controlled by the federal Government. The private corporations taking part in it simply have contracts to build the plants as directed by the Government and to operate them as ordered. These contracts follow the usual form of war-plant contracts of Defense Plant Corp., subsidiary of Reconstruction Finance Corp., under which at the end of the war the contractor has an option to purchase the plant at a price based on a depreciation scale. The Government owns the plants for making the rubber and the plants for the raw materials needed to make rubber; through Rubber Reserve Co., another RFC subsidiary, it buys the feed stocks for the raw-materials plants and orders the materials shipped to its various rubber copolymerization plants. The finished crude synthetic rubber is either sold to rubber-goods fabricators or title is kept by the Government and the fabricators make it up into military or other government articles under manufacturing contracts.

The cost to the taxpayers of the present construction program will be somewhere between $500,000,000 and $600,000,000; further expansion and the possible need for government financing of new rubber-fabricating equipment may bring the total investment close to a billion dollars.

The cost per pound of the synthetic rubber which will be made is something which nobody has bothered to figure very closely, because costs mean little during a war and we must have the rubber at any price. Raw materials for buna-S are being made in a variety of different ways, so that its cost may vary from plant to plant. Whether or not amortization of the Government's investment in plant facilities is figured in has a considerable bearing on the cost of the prod-

(Left) W. S. S. Rodgers, president of Texas Co. and chairman of the Temporary Committee on Synthetic Rubber, of the Petroleum Industry War Council. (Right) Bruce K. Brown, formerly director of research, Standard Oil Co. (Indiana), now assistant deputy petroleum coordinator, in charge of refinery technology

uct, and no one knows at what rate this will be paid off, if at all. Thumb-nail estimates are that buna-S will cost around 30 cents per pound, compared with recent prices for natural crude rubber of around 20 cents (though this has varied from 6 cents to $1); neoprene and thiokol have and probably will cost somewhat more; butyl probably will cost less. Quantity production and increased knowledge should bring the cost way down, but even if the 30-cent estimate sticks in the postwar period it will keep the price of natural rubber from getting out of reason and on its own merits buna-S will not be too costly for ordinary use.

Three types of plants are required to make buna-S—butadiene plants, styrene plants, and copolymerization plants. The oil industry's interests are entirely in the butadiene plants. At the beginning of the program it appeared that three industrial giants, the oil industry, the rubber industry, and the chemical industry, were battling among themselves for control of this new synthetic-rubber industry. But, unlike Solomon's baby, the industry was capable of being divided without injury. Under the present program the oil and chemical industries share in butadiene production. The chemical industry exclusively has the styrene end. The copolymerization plants, which actually make the crude synthetic rubber, are being built under contract by the rubber industry, but no operating contracts have yet been let (except for the small plants already completed under prewar contract) and it has not been decided who will operate them. Although copolymerization is a chemical process, and the rubber-goods manufacturing industry starts with the product of the copolymerization plants, it is probable that the rubber manufacturers will get the contracts to operate the copolymerization plants; at least they expect to.

Chemical Companies Making Styrene

At present all 705,000 tons of copolymer capacity is being constructed under contract with the "big four" rubber companies—Firestone Tire & Rubber Co., Goodyear Tire & Rubber Co., B. F. Goodrich Co., and U. S. Rubber Co. If the rubber industry gets the operating contracts it is expected that some of these copoly plants will be operated by the smaller rubber companies, or by groups of them together.

All of the 200,000 to 250,000 tons of styrene needed for buna-S is being made under contract by four chemical companies—Dow Chemical Co., Monsanto Chemical Co., Carbide & Carbon Chemical Corp., and Koppers United Co. Petroleum processes have been suggested for producing styrene, but the chemical companies insisted that if they were to be responsible for the purity of the styrene they must control the entire process throughout.

Methods of producing styrene are well known, and no particular problems are anticipated either in its production or in construction of the styrene plants. The copolymer plants likewise involve no particular engineering difficulties. Both these parts of the program are well advanced and can be kept abreast or ahead of butadiene production. In fact, there are copoly plants already constructed which are idle most of the time for lack of sufficient butadiene—but this situation will not last long.

Butadiene from the first was recognized as the bottleneck, and only during the last couple of months has this part of the program been pushed far enough along to make it certain that there will be sufficient butadiene to produce at least 400,000 tons of buna-S during 1943.

A word of caution in the use of figures is in order at this point. It takes three parts of butadiene and one part of styrene (plus small quantities of emulsifiers) to make a given quantity of buna-S rubber. But all the synthetic rubbers are figured in British long tons of 2,240 U. S. pounds (because that's the way the rubber-manufacturing industry always bought its crude) while all ingredients of synthetic rubbers are figure in U. S. short tons of 2,000 lb. This often leads to confusion, because butadiene and styrene capacities are given in short tons, and copolymer capacities in long tons. One short ton of butadiene, plus the necessary production of styrene, minus manufacturing losses, yields approximately 1.1 long ton of buna-S, so the ratio used by the Government in all its figures is 100 tons of butadiene to 110 tons of buna-S. Thus in speaking of butadiene to be made from alcohol the figure is 220,000 tons a year; in speaking of rubber to be made from alcohol-butadiene the figure is 242,000 tons.

The following table shows the government-owned butadiene plants now under contract:

GOVERNMENT BUTADIENE PLANTS, INCLUDING PURIFICATION EQUIPMENT

Contractor and location—	Est. cap'y short tons
By Thermal Cracking of Mixed Petroleum Hydrocarbons	
Shell Chemical Co. and Southern California Gas Co., Los Angeles, Calif.	85,000
Atlas Refining Corp., Shreveport, La.	10,000
Standard Oil Co. of La., Baton Rouge, La.	8,300
Carbide & Carbon Chemicals Corp., Charleston, W. Va.	5,000
Subtotal	108,300
By Catalytic Dehydrogenation of Butylene and Mixed Butylene and Butane	
Humble Oil & Ref. Co., Baytown, Tex.	30,000
Standard Oil Co. of La., Baton Rouge, La.	15,000
Neches Butane Products Co. (2 plants), Port Neches, Tex.	100,000
Sinclair Rubber, Inc., Houston, Tex.	50,000
Cities Service Ref. Co., Lake Charles, La.	55,000
Subtotal	250,000
By Catalytic Dehydrogenation of Butane	
Phillips Petroleum Co., Borger, Tex.	45,000
Sun Oil Co., Toledo, Ohio	15,000
Subtotal	60,000
Total butadiene from petroleum	418,300
From Alcohol by Carbide Process	
Koppers United (4 plants), Pittsburgh, Pa.	80,000
Carbide & Carbon Chemicals Corp. (3 plants), Louisville, Ky.	90,000
Carbide & Carbon (4 plants), Institute, Va. W.	80 000
Total butadiene from alcohol	220,000
Total of government-owned butadiene plants	638,300

These estimates of capacity, as explained previously, are round figures only, and actual output may not hit them right on the nose. The expectation is that output will exceed estimates by a considerable margin, particularly in the petroleum plants, partly because of conservative estimating and partly because of increased yield through use of higher temperatures than originally planned for certain plants.

To this table should be added approximately 100,000 tons capacity of butadiene from a large group of smaller oil companies participating in the refinery-conversion program. The approximately 640,000 tons of butadiene from the big, government-owned plants, will almost exactly feed the 705,000 tons of copolymer capacity now under contract. The additional 100,000 tons of butadiene from the refinery-conversion program will provide the feed stock for the 110,000 tons additional copolymer capacity soon to be placed under contract, and in the meantime, as it becomes available, will take up the lag in completion of the government butadiene plants. The additional 30,000 tons of copolymer capacity recommended by the Baruch committee to bring the total of buna-S to 845,000 tons is being reserved to take care of 27,000 tons of butadiene to be produced by alcohol or butylene glycol processes still under experimentation.

Rubber from Petroleum Section

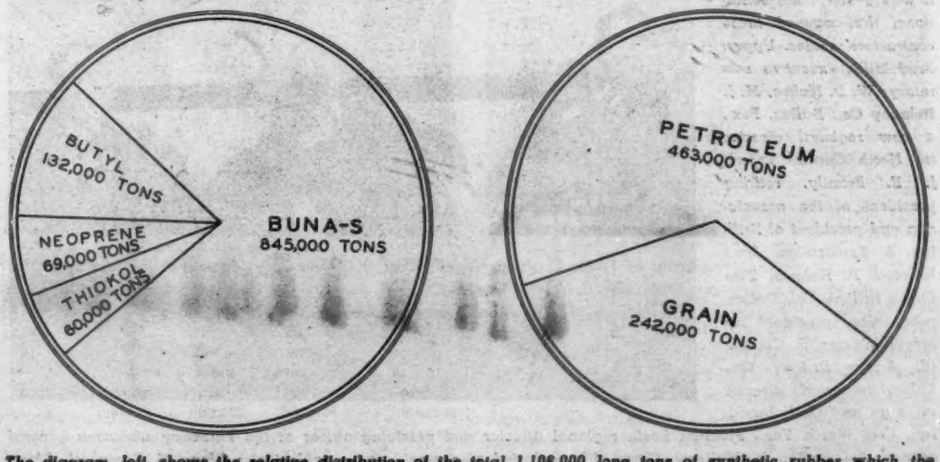
Starts on Page 29 of this issue

A comprehensive report of the nation's rubber situation, and the part petroleum is playing in supplying synthetic rubber, feature a special section in this issue.

This is the program recommended by the Baruch committee, and this is the program being followed by the rubber director. In fact, the Baruch report is being followed almost to the letter throughout. It was dated September 10, but it is still the authoritative text book on the rubber program and will remain so for many more months.

No completion dates are shown in the above table for any of the plants. Completion dates are in the contracts and they have been published variously in the past, but today they mean nothing. The whole construction program is being speeded up by every known device. The highest

(Continued on Page 181)



The diagram, left, shows the relative distribution of the total 1,108,000 long tons of synthetic rubber which the United States will be producing annually beginning in 1944. Right: Of the 705,000 tons of copolymer capacity now under contract petroleum will supply 463,000 tons, alcohol from grain will supply the remaining 242,000 tons

Drilling Contractors Fear Results of Labor Shortage

By H. STANLEY NORMAN

FEAR that depleted personnel and equipment will so emaciate the country's drilling organizations that they cannot meet anticipated emergency expansion of exploratory operations was voiced in Tulsa last week by numerous speakers before the second annual meeting of the American Association of Oilwell Drilling Contractors.

Deferred operations are causing a heavy accumulation of exploratory obligations and contractors are concerned over the probability that they will be caught without necessary facilities when the Government and producers call for expansion of drilling.

Frequency with which manpower problems were mentioned both in formal discussions and lobby conversations stamped personnel worries as the cardinal current concern of contractors. The apparent paradox between indicated drilling requirements and restrictive regulations which are gradually draining off the men and facilities of contractors caused sharp criticism of certain government policies during the 2-day program, November 19 and 20.

Contractors were told that the Office of Petroleum Coordinator has projected an exploratory drilling program for 1943 calling for at least 4,500 wildcat wells. This program, they were advised by D. R. Knowlton, OPC director of production, may be increased to 6,000 wells, if the desired reserves are not discovered by the more modest total.

He outlined salient features of the Controlled Materials Plan through which the OPC hopes it will be possible to channel supplies into the services which are most urgent. Exploratory drilling, Mr. Knowlton affirmed, is one of the most critical phases of petroleum operations because of the failure of discoveries in recent years to equal production.

OPC will exert its full power, Mr. Knowlton told contractors, to make available all the equipment necessary for drilling wildcat wells.

Manpower problems of the drilling contractors result from numerous factors related to the war. The attraction of war industries in which oilfield workers are paid higher wages than received on drilling operations and offering permanent employment for the duration is one of the most difficult problems facing contractors. Deferment of drilling operations because of material shortages has made it impossible for contractors to keep all of their regular crews continuously employed. Consequently, oil workers, yielding to exigencies of personal economics, have migrated into shipyards, machine factories, aircraft plants, and other war industries where wages are as good or better and the work week regular.

Contractors considered various methods of retaining their employes in the fields and two or three employers reviewed specific action they have taken to offset the pull of war plants on skilled manpower. John A. Chapman, Cron and Gracey, Houston, Tex., said that his company is now paying travel time at the regular working rate. He suggested that contractors consider the establishment of central points through which drilling crews could be assigned immediately from completed wells to new operations, thus avoiding the lags between jobs. The service would be voluntarily maintained by contractors with one organization designated in each major district through which all members would report the need for or availability of drilling crews.

Sporadic Work Causes Migration

Contractors recognized that the migration of crew members into war industries is caused almost entirely by the sporadic nature of drilling operations. The inherent difficulties of holding crews intact between wells has been aggravated during the past 11 months by the reduction of approximately 40 per cent in total completions.

There was no general agreement on the proposal to designate central points where contractors would report available crews and where they might fulfill their labor requirements. Some contractors thought the suggestion was too closely related to hiring halls. Others pointed out that voluntary exchange of information on available field workers among contractors is currently making full use of the system.

Contractors were told that it is their patriotic duty to ask military-service deferment for their key men who are essential to their operations. Maj. I. O. Hagen, occupational deferment officer for Oklahoma, one of the Friday afternoon speakers, insisted that employers who fail to ask deferment for essential men are derelict in their patriotic duty. Major Hagen particularly emphasized the necessity of giving complete and specific information on the work performed by the man for whom deferment is requested. He warned contractors to make deferment applications before their key men are called for induction, pointing out that local draft boards are justifiably suspicious of last-minute pleas.

Lt. Col. J. T. Coatsworth, Washington, D. C., assigned to the Selective Service System, urged contractors to appeal deferment cases when advised that local boards had refused to honor a

It was a story, not conditions, that caused these contractors' smiles. Upper: Brad Mills, executive secretary; W. D. McBee, M. J. Delaney Co., Dallas, Tex., a new regional director for North Central Texas; J. E. Brantly, retiring president of the association and president of Drilling & Exploration, Inc.; Howard P. Holmes, Two States Drilling Co., Dallas, new vice president at large; Warren S. Churchill, Arrow Drilling Co., Tulsa, reelected director at large and C. J. Davidson, Fort Worth, Tex., Permian basin regional director and presiding officer at the Thursday afternoon general session. Below: Ben M. McGraw, Carmi, Ill., reelected vice president for cable tools; Glenn M. Campbell, Glenn Drilling Co., Tulsa, new vice president for rotary operations, and George P. Livermore, chairman of the rotary drilling practices committee and a new director at large

single application from at least one drilling firm. Lloyd Noble, president of Noble Drilling Co., Tulsa, pointed out that 1 to 3 years are necessary to train even the least essential members of drilling crews. Mr. Noble said that the drilling industry could not start more than 5 per cent of the idle rigs in this country if suddenly called on to increase the rate of exploration because of the shortage of manpower.

Contractors were urged to abolish their reticence in asking deferment for essential men and to use every means at their disposal to retain necessary personnel, because of the critical nature of their operations in the war program.

One of the most involved questions, that of double time for the seventh consecutive work day, was referred to new officers and directors with instructions that a specific ruling be sought from the War Labor Board on the classification of drilling firms. Representatives of the Wages and Hours Division, Department of Labor and from the Dallas, Tex., regional office of the WLB, explained a recent Supreme Court ruling, holding that drilling contractors are liable under the Wage-Hour Act.

Material Life Elongated

Specific suggestions were made at the closing session Friday by J. S. Montgomery, general superintendent, northern region, Phillips Petroleum Co., Bartlesville, Okla., on how to obtain longer service from drilling machinery. He recommended treatment of natural gas containing less than 200 grains of sulfur before consumption in drilling engines. If treating facilities are unavailable, he suggested conversion to butane fuel, declaring that the higher cost would be offset by longer engine service. He was unable to explain why, but said that natural gas containing more than 200 grains of sulfur did not appear to be corrosive to an injurious degree. Mr. Montgomery stressed proper lubrication of all rotary-rig equipment.

Highlight of the meeting from an attendance standpoint was the annual banquet Thursday night featuring an address by Rep. Wesley Disney, Tulsa. Congressman Disney warned of the malignant tendencies of bureaus, how they often evolve into branches of Government cloaked with executive, judicial, and legislative power. Blame for the evolution of bureaus, however, was placed on the voters who send representatives to Washington who grant powers to the executive branch which makes bureaucracy possible.

N. H. Wheless, president of Wheless Drilling Co., Shreveport, La., was elected president of the association, succeeding J. E. Brantly, president of Drilling & Exploration Co., Inc., Los Angeles, Calif.

Other officers elected were: Howard P. Holmes, Two States Drilling Co., Dallas, Tex., vice president at large; Glenn A. Campbell, Glenn Drilling Co., Tulsa, vice president for rotary tools; Ben M. McGraw, Carmi, Ill., vice president for cable tools; Arch Rowan, Rowan Drilling Co., Fort Worth, Tex., and A. S. Ritchie, McPherson Drilling Co., Wichita, Kans., vice presidents; Harry W. Bass, Bass Drilling Co., Dallas, Tex., treasurer, and Brad Mills, Dallas, executive secretary.

New regional directors elected were: Thomas M. Rowan, Long Beach, Calif.; W. D. McBee, Dallas, Tex.; S. C. Canary, Tulsa, and Fred Manning, Denver, Colo. Sixteen regional directors were reelected from the 1942 slate.

New directors at large are: George A. Livermore, Lubbock, Tex.; Glenn Campbell, Jack Milhoan, Tulsa; A. S. Ritchie, Wichita, Kans.; Joe Morris, San Antonio, Tex.; Arch Rowan, Fort Worth, Tex.; J. O. Chapman, Houston, Tex., and Harry W. Bass, Dallas, Tex. Fifteen member of the 1942 panel were reelected.

Women are filling the refinery posts of men drafted into the military forces and attracted into other war industries. Here one of the women workers at a Gulf Coast refinery is shown at a welding job previously reserved for men workers. Most coastal refineries are using women to some extent and are participating in training programs which will create a reserve from which to draw as selective service digs deeper into available manpower

This Week...

PRODUCTION.—National quota of all liquid petroleum products in December set at 4,015,900 bbl. daily; was 4,031,400 bbl. in November; actual output last month a year ago, 4,334,900 bbl. . . . Texas Railroad Commission issues order setting water-oil ratio of 10 to 1 bbl., in East Texas. West side operators threaten suit, claim it deprives them of oil in place. Order, based on net water, designed to force return of brine to producing formation, halt decline of pressure. . . . California's December quota raised to 815,000 bbl. daily, by OPC; increase of 33,000 bbl. New wells in old California fields have surprising initials, in some cases. Redevelopment most attractive source of new production, at the moment. . . .

REFINING.—Douglas Oil & Refining Co., 10,000-bbl. plant at Wilmington, Calif., sold to Treasury Department, for dismantling and shipment to Soviet Russia. . . . Canadian synthetic-rubber program expanded, now embraces several plants. . . . Defense Plant Corp. increases appropriation for Crown Central Petroleum Corp., expansion to about $7,000,000. . . . Direct isomerization of normal hexane to neohexane, now reported on commercial scale, by comparatively simple process. . . . Gulf Coast plant operators solving manpower shortage by employment of women. Results surprisingly satisfactory. . . .

TRANSPORTATION.—Nearly 1,400 miles less distance from East Coast to North African fuel dumps, makes eastern ports logical supply base, contributes to reduced gasoline rations, necessitates squeezing more oil through overland facilities. . . . Railroads increase eastern deliveries slightly, to 784,921 bbl. daily. . . . Merger of Buckeye, Indiana, Northern, and New York Transit systems proposed, for simplified operation. . . . Petroleum truck transports handle 10 per cent of all over-the-highway traffic, nearly 61 per cent greater than a year ago. . . . Application filed with WPB for 20-in. products line from southwest refining centers to New York. . . .

DRILLING.—OPC projects minimum of 4,500 wildcat tests next year, would like to have 6,000 drilled. . . . Contractors concerned over manpower shortage. Declare no more than 5 per cent of currently idle rigs could be started, if emergency call should arise. . . . Selective Service System officials urge appeal of rejected deferment applications on really essential men. . . .

PRIORITIES.—Field representatives groomed at Washington to institute Controlled Materials Plan, early next year. . . . Reports that repair and maintenance materials soon will receive AA-1 rating, discounted by OPC; upgraded ratings apply only to cases of extreme emergency. . . .

RATIONING.—Opponents consolidate strength for eleventh-hour fight. Outlook dull for postponement. Three resolutions for 90-day delay pending action in Congress. Administrators Jeffers, Henderson, Eastman proceed with plans to limit all drivers, effective December 1. Bureaus now have "face saving" job. Postponement might be construed as minimizing the necessity. . . .

MARKETS.—OPA generally raises tank-wagon prices on fuel oil in Michigan Peninsula area 0.5 cent. . . . Refinery markets resist depressing influence of imminent reduction in gasoline demand. . . . Crude buyers post promptly in all new fields, to solidify position with producers, improve chances of retaining connections indefinitely. . . .

Location of Oil Reserves Big Factor in Supply Deficiency

(Part 2)

In this concluding instalment of an analysis of oil reserves and their distribution with reference to requirements, it is found that a balance between supply and demand can be attained temporarily under most favorable circumstances. Unless additional drilling is encouraged, however, any sudden increase in demand would cause a production crisis whose effects would be far-reaching.

The general predicate for this analysis was laid in the first instalment appearing on Pages 14, 15, and 31, The Oil and Gas Journal, November 19. This second part completes the detailed discussion of various producing areas.

By W. V. HOWARD

West Central district: Illinois, Indiana and Missouri form one of the most important refinery areas in the nation with a normal demand for 500,000 bbl. of crude daily. In October 1941, the district fell 60,000 bbl. short of meeting this demand and in October 1942, the deficiency was increased to 218,000 bbl. daily. If the quantity of oil which must be moved through this area to the east is added, a total of 1,100,000 bbl. daily must enter the area.

On July 1, Illinois had estimated reserves of 5.1 times annual production, calculated on a basis of the first half-year's output. Owing to a fall in production, the state reserves are 5.8 times annual production at current rates. Expressed differently, the enforced reduction in output is already noticeably extending the years' supply, indicating that insufficient reserves are being discovered to hold production steady and also that without the addition of large reserves, continued declines are practically certain.

It is probable that the decline will not increase the deficiency in this area as much as during the last year, or 158,000 bbl. but an additional import requirement of 100,000 bbl. daily in October 1943 is not out of line, which, added to a decline of 20,000 bbl. farther east will make the requirement for oil imported into the central and eastern districts late in 1943, about 1,220,000 bbl. daily.

Oklahoma-Kansas

Northern Mid-Continent district: Oklahoma, Kansas and Nebraska produced 345,000 bbl. daily in excess of refinery requirements in October 1941 and 332,000 bbl. daily in October 1942. Thus, the rise in Kansas output to an all-time high is not sufficient to balance the decline in the other two states. During 1941 and the first half of 1942, Kansas production was at the rate of one-ninth of its estimated reserves annually, indicating discoveries adequate to maintain a uniform level despite increased production. Since July 1942, the discovery rate has not been maintained and present output is at the ratio of 1:7.3 of the estimated reserve. Thus, although Kansas production could be increased, possibly as much as 25 per cent, the increase would be temporary and would hasten the depletion of its reserves.

With negligible reserves, Nebraska does not now enter into the picture and Oklahoma's output has declined steadily since 1937, except for a slight reversal in 1941. With the exception of a few fields in which production is held below the maximum figure, there is little possibility of any increase in production in Oklahoma from existing fields and discoveries have not been of major importance.

Although there is little prospect of new fields east of the Mississippi in the near future whose output would make up for any appreciable proportion of the area's decline, this is not the case in the northern Mid-Continent. The Viola-Misener trend to the south of the Central Kansas uplift may be extended and Cumberland, Apache and Pauls Valley suggest the possibility of other large pools in southern Oklahoma. The best possibilities are, thus, around the margin of the Anadarko basin and in the strong folds paralleling the Arbuckle and Wichita belts.

Since discoveries and extensions during 1942 have not kept pace with production in the Mid-Continent, it seems probable that the excess production will decline during the next year about 15,000 bbl., or slightly more than it has since October 1941, so that indicated demand from states to the south and west 1 year from now will be 903,000 bbl. daily.

South Central district: Compared with October 1941, production from Arkansas, Louisiana and Mississippi shows a slight gain. In the different sectors, the only important gain is in North Louisiana where production has risen nearly 20 per cent. Most of this gain is offset by a loss from the Louisiana coastal region. The apparent uniformity of production in Mississippi gives the impression of relatively settled conditions which is at variance with the facts as it is a one-field state and Tinsley's production has fallen 33 per cent from its peak in February. This has been credited to transportation difficulties but the field is on the pump and such a decline might easily be a natural one. It seems entirely likely that in October 1943, Mississippi's production may be 20,000 bbl. daily below present levels and wildcatters have greatly reduced operations there following an almost unprecedented succession of dry holes, interrupted by two minor discoveries.

In North Louisiana, hopes for increased production center around deep pays in such fields as Haynesville and added discoveries in the east end of the Wilcox trend. Coastal Louisiana's decline can be credited almost entirely to transportation difficulties and this is one area in which estimates of years' supply in reserve are misleading. Many of the fields in this section have only a few wells and, therefore, a small proven area but structural and sand conditions strongly indicate much larger probable reserves. Based on the different rates of production, North Louisiana's reserves stood at 7.5, 8.9 and 8.5 years' supply on January 1, July 1 and November 1, 1942. On the same dates, coastal Louisiana's reserves stood at 9.2, 9.2 and 9.8 years' supply respectively. The actual as well as potential improvement in coastal Louisiana's position suggests that, given adequate transportation facilities, Louisiana's exports to the North and East will increase sufficiently to offset Mississippi's anticipated decline.

Arkansas' position has greatly improved following the discovery of the Midway field and increased demands for gas from the distillate fields can be expected to increase production from the Smackover lime pools. Wildcatting in 1943 has been successful in adding sizable reserves and with the liberal allowables granted Arkansas' producers, and assuming transportation facilities, it is considered that production may reach 95,000 bbl. daily by next October, an increase of 21,000 bbl. for the state and also for the whole district.

Based on the size and number of recent discoveries, it is possible that major discoveries will be uncovered in this district during the next year. The Lower Cretaceous and Jurassic possibilities of Arkansas and North Louisiana have been far from exhausted, the Wilcox trend has many gaps between fields and coastal Louisiana has done much to confirm the belief current for some years that oil possibilities are limited only by the depths to which wells can be drilled economically. In this area, high costs discourage prospecting but this is balanced by the unit ownership of a large percentage of the prospects.

More remote possibilities are Cretaceous accumulations along and just north of the Wilcox trend and the extension of the trends into Mississippi.

Texas-New Mexico

Southwestern district: Texas and New Mexico, with nearly 60 per cent of the nation's reserves and only 37 per cent of its current production provide the most obvious possibilities for increased production. Based on these factors alone, it would appear that increased transportation facilities are all that is needed in order to usher in a period of security from shortages. Twenty per cent of Texas' production comes from Districts 1, 4, 5, 7-B and 9 in which the average daily production is below 12 bbl. per well per working day. With the exception of District 4 (Laredo) more than 90 per cent of the wells are on the pump and many of the fields are exempt from shutdown. None of the districts produce more than 90 per cent of their allowable and with the exception of the Laredo district, transportation is adequate. Thus little or no additional production can be expected from the other four districts which are the San Antonio, East Central Texas, North Texas and West Central Texas districts. The greater part of the produc-

tion from the eastern Texas district comes from the East Texas field and most operators agree that until an adequate water-disposal program is put into effect, that field's output is possibly too high and certainly should not be increased. That accounts for an additional 30 per cent of Texas' production so that only 55 per cent need be considered as susceptible of much increase.

The combined Gulf Coast fields produce more than 25 per cent of Texas' output and are currently running about 25,000 bbl. daily below the allowable for the two districts (Houston and Corpus Christi). Given adequate transportation, this could be made up without any bad effect and another 75,000 bbl. could safely be run. Adding 100,000 bbl. daily to current production would reduce the years' supply in reserve to 20.5, which is safely above the danger point. Present methods which are intended to flow the deep coastal wells for as long a period as possible and to prevent retrograde condensation and resulting loss of oil require a lesser proportionate recovery than in other districts.

The Laredo district includes many stripper fields and a number of discoveries which are susceptible of more rapid development than they are now receiving. Some of the more recently developed fields, like Kelsey and Seeligson have more than 100 flowing wells and very small allowables. It is probable that the Laredo district could produce an additional 30,000 bbl. daily without waste, despite the steady decline of a large number of the older fields in the district.

With 99 per cent of its wells on the pump, it is unlikely that any large increase in production could be safely obtained from the Panhandle leaving the Permian basin fields of West Texas and New Mexico to make up the remaining deficiency. Production from this area has dropped 100,000 bbl. daily since last October. This could be restored and another 150,000 bbl. added making a total of 550,000 bbl. daily. This output could probably be maintained for at least 2 years without waste.

Thus, the southwestern district, including Texas and New Mexico could add a total of 380,000 bbl. daily to present production and maintain it for 2 years with the continuation of development at the present rate.

Additions to present reserves by reason of major discoveries may be expected in the Permian basin and in South Texas. The largest reserves found in a single field during the past few years are in the West Texas district, not only in the deep Ellenburger pay but also in the Permian lime. The Wilcox trend in the coastal area and deep pays in East Texas are also promising, although the Texas Wilcox has not yielded much in the way of large fields to date. The important East Texas discoveries yield heavy crude and are, therefore, less desirable for certain purposes than the crudes which they supplement. In New Mexico, there have been no Ellenburger tests drilled to date but the proximity of good Ordovician production in West Texas leads to the belief that a substantial addition will be made to reserves when economic conditions warrant deep tests in New Mexico.

Rocky Mountain district: Colorado and Montana have seen much successful prospecting in late years and their reserve situation is good. The small output of these states could be increased but not to an extent sufficient to have much effect on national production. Wyoming has many undrilled structures and much potential production held back from lack of markets. This district has, however, increased its output rapidly during the past 2 years and another 10,000-bbl. increase is probably all that can be expected from it in the near future. Much of the available crude is a heavy black oil which still sells at a very low price compared with high-gravity crude from the same area.

TABLE 3—ESTIMATED FUTURE RELATIONSHIP BETWEEN REFINERY RUNS AND PRODUCTION

District—	Present cumulative deficiency	October 1943 Estimated prod.	October 1943 Excess or deficiency	October 1943 Cumulative	October 1944 Estimated prod.	October 1944 Excess or deficiency	October 1944 Cumulative
East Coast	—644	0	—644	—644	....	—844	—644
Appalachian	—710	82	—66	—710	82	—66	—710
Mich., W. Ohio, Ky.	—882	87	—192	—902	57	—202	—912
Ill., Ind.	—1,100	182	—318	—1,220	132	—368	—1,280
Okla., Kans.	—768	649	317	—903	639	307	—973
Ark., La., Miss.	—542	491	247	—656	491	247	—726
Tex., N. Mex.	—333	1,851	589	—67	1,851	589	—137
Wyo., Mont., Colo.	—300	129	43	—24	129	43	—94
		3,441			3,369		

Summary

Table 3 shows the current estimated excess of refinery demand over production and the estimated supply and demand in October 1943 and 1944. These figures are based upon four factors which are all open to considerable question. These are the construction of adequate transportation facilities to get the oil from the fields to the markets, maintenance of drilling and discoveries at the current rate, no increase in refinery demand and the ability of the refineries to handle heavy sour crudes as effectively as they now utilize other oils. Even allowing these assumptions, present estimates show that the nation cannot quite supply its own needs without increasing drilling and reversing the downward trend in discoveries which has now continued for 3 years. There is considerable discussion now of the possibility of having to move oil from West Texas into California to augment declining production and supply the increased demand there. This would increase the currently estimated crude shortage. Shutting off any foreign production or an increase in military demands for crude would increase the shortage and such an increase can confidentially be expected should the war in the Pacific become a full-scale all-out offensive.

There can be little doubt, therefore, that so long as there is a possibility of a sudden major change in demand, the nation's oil position is precarious. Further rationing of civilian supplies will, in the opinion of many, seriously affect war production and disrupt public transportation systems. There is a widespread fear that measures urgently needed to increase production will remain in the debate stage until it is too late to take any measures to meet a sudden change in demand without overproducing fields to such an extent that the nation's oil future will be so endangered that permanent reliance on imports will ensue.

Priorities Asked on Steel For 20-in. Products Line

WASHINGTON, D. C.—Application was made to WPB Monday for priorities to construct a 20-in. products line from Southwest refining areas to the Philadelphia-New York consuming area, it was disclosed Tuesday by Petroleum Coordinator Ickes testifying before the House petroleum subcommittee.

Mr. Ickes said it is a preliminary application and he gave no details of exact location of the line or amount of material required, but said it probably would have several terminals at refining centers, would take 9 to 12 months to put in operation if materials and manpower are available, and could deliver 200,000 bbl. daily of products to the East Coast area. He did not indicate WPB reaction to the application but said Vice Chairman Eberstadt had recently promised higher priority ratings for oil projects connected with the war including 100-octane plants and the 24-in. crude line. The crude line, he said, has been delayed somewhat by low priorities but now that this has been corrected there is a delay in completing pumps and equipment due to "kidnaping of skilled labor by Mr. Kaiser to build ships on the West Coast." He anticipated that the big line would be laid to Norris City, Ill., by December 15 but that pumps would not be ready until after January 15. Deliveries to the East Coast by all methods are now averaging about 1,200,000 bbl. daily, he reported, but oil requirements of England, Russia and the African campaign make it imperative to increase this rate of delivery.

Under committee questioning, Mr. Ickes said too many federal agencies control oil matters and issue conflicting statements, but added that "something is in the works now" which makes him hopeful that he will soon be in position to do a better job. This was interpreted as pressaging early issuance of an executive order centralizing in him authority over oil matters.

Alfred Jacobsen, president of Amerada Petroleum Corp., said that wildcatting and geophysical prospecting have increased recently, owing largely to removal of fear of repeal of tax-deduction privileges for depletion and intangible drilling costs in the recent revenue bill. He outlined for the committee in detail conditions surrounding discovery and production and said the industry probably will drill around 3,500 wildcat next year if materials are available and tax fears removed and with luck in discoveries this might locate the needed increase in production. He strongly opposed subsidies for discovery, saying many would drill for the subsidy instead of for oil, and added that an increased crude price would help exploration particularly in some fields. Asked if the industry could increase production by another million barrels daily, Mr. Jacobsen said this probably could be done within a year with luck in discoveries, closer drilling of known fields and new pipe lines from such fields as West Texas and New Mexico.

STATE CAPITALS...

KANSAS

FIELD TESTS to determine productivity of all wells in 14 Kansas fields will be started November 27, the Corporation Commission announced at Wichita last week. Fields to be tested for precise data on productivity include Driscoll, Dubuque-Lansing-Kansas City, Dubuque-Arbuckle, Forest Hill-Arbuckle, Greenvale-Arbuckle-Gorham, Greenvale-Kansas City, Gustason-Arguckle, Sellens-Arbuckle, Sellens-Lansing-Kansas City, Sellens-Shawnee, Vaughn-Arbuckle, Vaughn-Gorham, Vaughn-Lansing-Kansas City, all of Russell County, and the Trapp-Lansing-Kansas City in Russell and Barton counties.

ARKANSAS

A STATE-WIDE oil and gas hearing will be held at 9:30 a.m., December 16, in the Union County Court House, El Dorado. The commission officials expect this hearing to be the largest both in matters to be discussed and in attendance for several years.

Daily production quotas for the 35 oil and gas pools of South Arkansas for the months of January, February and March, 1943, will be decided at the hearing. At the present time production from these 35 oil and gas pools is averaging 75,000 bbl. of oil and natural gasoline daily, together with approximately 90,000,000 cu. ft. of gas.

Three of the 16 pools producing sour gas in South Arkansas will come up for particular discussion. These fields are Dorcheat, Macedonia and McKamie. Some 50,000,000 cu. ft. of gas is being produced each day by these three fields along with 5,000 bbl. of water-white distillate. The gas has been wasted to the air, awaiting the construction of a large desulfurization plant at McKamie to serve that field and another plant at Dorcheat to service the Dorcheat and Macedonia fields. The commission desires to discuss with the operators the advisability of closing to production the sour gas producing zones of the Dorcheat, Macedonia and McKamie fields until the desulfurization plants are in operation. It is estimated that these plants will not be in operation before May 1943.

Also in the Dorcheat and Macedonia fields another horizon is now producing sweet gas. This gas in the amount of approximately 20,000,000 cu. ft. a day will go to supply war industries. However, a proration formula designed to give equity among the various producers must be decided upon at the hearing.

McAlester Fuel Co. is proposing in the Macedonia field, where the spacing pattern is one well to each 80 acres, that field operation be upon a 160-acre basis, i.e., one 80-acre tract produced from the Cotton Valley and the other 80 acres from the lime formation. Such an arrangement would also allow the interchange of production from well to well and facilitate field operations to the advantage of all concerned. McAlester has fostered unit operation for the Dorcheat pool.

OKLAHOMA

PURCHASERS AND PRODUCERS have been called to Oklahoma City for the regular monthly proration and market-demand hearing December 1. The testimony presented will form the basis for the December proration schedule.

Informal discussion of the market demand at 10 a.m., in the Corporation Commission's courtroom will precede the formal proration session at 11 a.m.

Texas Order Penalizes Failure to Return Salt Water to Oil-Producing Horizon

AN ORDER LIMITING water-oil ratio and maximum reservoir-liquid displacement in the East Texas field, designed to halt the decline of bottom-hole pressure, was issued last week by the Railroad Commission which also set the state-production allowable in December at 1,470,658 bbl. daily.

A group of operators on the west side of the East Texas field threatened Monday to file an injunction against the Railroad Commission if it does not amend its water-oil-ratio order issued last week. They claim the operation of marginal wells cannot be restricted under the present law, that the order denies operators a chance to recover oil under their property and that numerous wells in the Gladewater-Kilgore area would be ruined. Commissioner Olin Culberson in his dissent to the order filed Friday made the same objections.

The new East Texas order, effective December 1, specifies that no well in the field may be operated to produce more than 10 bbl. of water for each barrel of oil. Any well exceeding the ratio of 10 bbl. of water per 1 bbl. of oil will be allowed to produce daily only that number of barrels of water determined by multiplying 10 by the daily oil allowable for the well as computed under the existing allocation formula. The water volume thus obtained will be designated as the daily water limit in barrels that the well will be permitted to produce in any one day from the oil reservoir. The daily oil allowable of the well will be determined and assigned by dividing its daily water limit by its producing water-oil ratio.

If an operator is returning water to the reservoir, or if water is being returned on his behalf, the water-oil ratio on the well from which the returned water was produced will be computed on a net basis. The term "net water" was defined in the order as the difference between the volume of water produced from a well and the volume of water from that well which is returned to the producing formation from whence it came. In establishing the December allowable at 1,470,658 bbl. daily, the Railroad Commission went 126,258 bbl. above the daily average quota assigned by the Office of Petroleum Coordinator. Purchasers nominated 1,589,998 bbl. daily from Texas fields during December. The commission authorized 22 producing days in December for all fields except those yielding preferred crude in Districts 2, 3 and 9.

Transfer of the allowables of wells in the East Texas field which have ceased to flow and for which no pumping equipment can be obtained under M-68, will be permitted, after a suitable hearing.

The state-wide hearing in Austin November 19 was followed by declarations from members of the Railroad Commission that the effort to maintain adequate petroleum reserves in this country is only half won and that the succeeding phases of this program must be carried to Washington. Ernest O. Thompson, chairman, and Beauford Jester, junior member, again called on Leon Henderson, price administrator, to thaw frozen crude prices to the extent necessary for replenishment of reserves.

"There is no doubt in my mind," declared Mr. Thompson, "that if the price administrator will allow the price of crude to come to parity with other basic commodities, we can probably uncover enough flush fields to make possible the production of 5,000,000 bbl. of oil per day over a sustained period. In order to keep our current reserves up to standard," he continued, "we must discover a new 30,000,000-bbl. field every week and this is not being done for the simple reason that the price does not justify wildcatting."

Supporting the Railroad Commission's move to limit the water-oil ratio in the East Texas field, were reports from state engineers showing that pressure on November 1 stood at 1,015.22 lb., a decline of 5.49 lb. since October 1.

J. K. Baumel, production engineer for the commission, testified that 1,241 wells in the field were producing 347,225 bbl. of the total water, or 80 per cent of the field's aggregate, while recovering 19,940 bbl. of oil or 3.9 per cent of the allowable oil. He estimated that the water-oil ratio order would lower crude production from these wells to about 5,000 bbl. daily and that, in some instances, the reduction would be to as low as 4 bbl. per well. West-side operators protested that production would be driven from their properties to the center and eastern parts of the field, violate the marginal-well law and increase cross-migration.

Joe Zeppa, Tyler, Tex., operator, opposed compulsory closing of water wells, asserting that in East Texas it would aggravate a bad condition under which wells in the western part now are being drained of oil to the benefit of wells in the more favorably located sections. Mr. Zeppa has spearheaded a drive to transfer allowables from high water-ratio wells to more favorably located properties. A chart of his plan showed that a water well on the west side making 10 bbl. of oil would decline to 5.4 bbl. in 9 months. Under the Zeppa plan, the allowable of the water well would be figured on a basis of its normal decline and this allowable transferred to another part of the field.

J. S. Hudnall, Tyler, Tex., engineer, testified that unequal withdrawals in the center of the field resulting from transfer of allowables would be relatively small and would, to a large extent, be compensated by increased migration of oil from the western side. He estimated that west-side properties had lost about 25 per cent of the oil originally in place by migration.

Pressures in certain areas have declined to 771 lb., Mr. Baumel testified in his review of physical conditions. He said the field contains 18,000 flowing wells, 7,000 on pump and 900 producing by gas lift. He estimated that pressures would remain fairly static at 1,050 lb. with the production of total fluid from the field limited to 625,000 bbl. daily.

The OIL AND GAS JOURNAL

PRODUCING REFINING NATURAL GASOLINE PIPE LINE

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Rationing Solution

Within a few days some 80 million people are scheduled to join the 50 million in the eastern and southeastern parts of this country who for several months have known what it means to get along with a fraction of their normal gasoline requirements. The protests to Washington reflect the fact that consumers realize that the severe restrictions will be the greatest hardship of the war.

The seriousness of the situation that could develop from this curtailment in the use of approximately 28 million motor vehicles becomes more apparent as conditions are analyzed and the start of national rationing nears.

Two conclusions appear justified. An arbitrary and fixed application of the gasoline-rationing program without regard to varying positions of millions of car users will bring a transportation crisis with reactions assured in reduced war production.

There are those who for a time can do their part as civilians with the minimum quantities of motor fuel available under the rationing plan. There are others whose contributions in the war effort require continued motor transportation ranging up to normal use. A few general rules are not a sufficient guide as to needs and the rationing boards should have the authority to act upon applications as individual positions justify. Varying conditions by areas and by occupations must be recognized in the enforcement plans.

Unless this situation, the importance of which increases daily, receives the required consideration and action, war production will be crippled at its most vulnerable and interrelated points—transportation and manpower. If this happens more will be lost than gained by the rubber-conservation program.

It must be kept in mind in this connection that the alternate methods of transportation—airplanes, railroads, street cars, and buses—are already overcrowded.

The second thought is that the manufacturing phases of the petroleum and rubber industries must be given every assistance over the next few months to the goal that any threat of a rubber shortage will be ended. Motor transportation plays too important a part, not only in the conduct of the war, but also in the civilian economy and in civilian morale from which the war derives its support, to be restricted over a prolonged period.

The answers as to what has to be done are revealed in this "Rubber From Petroleum" number. Stocks on hand plus the reclaiming operations while adequate for the immediate military needs and the essential civilian requirements, must be backed up with expanding synthetic supplies from month to month with a production rate of a million tons yearly in another 13 months.

It is strange that in all the discussions from day to day at Washington and elsewhere regarding rubber practically nothing is said about the core of the problem—the tremendous task that confronts petroleum refiners acting for themselves and for the Government in furnishing the bulk of ingredients that go into the manufacture of the synthetic products.

The public appreciates the job involved in building a 10 to 20-million-dollar plant for the manufacture of tanks, airplanes, or other war materials and equipment. But most of these are of minor importance in size and in the construction and operating difficulties involved compared to the major phases of the synthetic-rubber plans.

Petroleum refiners and allied operators have the responsibility of building plants involving expenditures of nearly a billion dollars for the manufacture of rubber. This has been accurately termed a 5-to-10-year program under normal conditions. It now has to be squeezed into a period measured in months. The extent and duration of gasoline rationing will be dependent upon how supplies and manpower are made available to those who have this most difficult manufacturing undertaking of the war.

Export Restrictions Depress Production In Colombian Fields

By J. P. O'DONNELL

NEW YORK, N. Y.—All countries engaged in the large-scale production or refining of petroleum, whether or not they are situated in areas of actual combat, have been affected to some extent by the war. Countries outside the war areas have been affected by the withdrawal from peacetime uses of the tankers upon which they are all dependent, either for importing to offset deficiencies or for exporting to dispose of surpluses. None of the major producing or refining countries enjoys an exactly balanced petroleum economy in that it does not import or export crude oil or refined products.

This condition affects all the countries still beyond the combat area from India through the Middle East and all of the Western Hemisphere. Probably the most adversely affected of all the nonbelligerent nations is Colombia, South America's second ranking oil-producing country and, under normal circumstances, one of the world's first 10.

With a comparatively small domestic demand, the bulk of Colombia's oil is exported. Last year, her production amounted to 24,639,000 bbl. and of this total, 22,194,000 bbl. were exported, 90 per cent of the output. The principal destination of these exports was Canada though appreciable quantities also were sent to the Netherlands West Indies for processing at refineries there and to the United States. In more normal times, Colombia had a substantial European market with France as her major continental customer. Canada and the Netherlands West Indies have always been large importers of Colombian crude but the United States, until last year, had not taken it in a large volume since 1935.

Dependent on Exports

Since Colombia's oil industry is so greatly dependent on exports it is obvious that the withdrawal of tankers has caused serious consequences there. In contrast to her 1941 production of 24,639,000 bbl., which, incidentally, was only 926,000 bbl. below the all-time high of 1940, it appears today that Colombian production in 1942 will be less than 10,500,000 bbl. Thus a decline of almost 60 per cent for the year is indicated. This would be the lowest annual production total for the country since 1925 when it moved above 1,000,000 bbl. annually for the first time and was just beginning the development which was to elevate the country to rank among the first 10 oil-producing countries of the world.

Actually the decline in Colombia's production has been more severe than the above comparison indicates. Early this year is was at record levels but in September the daily average rate had declined to 11,600 bbl. Back in February, production reached an all-time peak of 83,500 bbl. per day and since then it has dropped 86 per cent. September's low rate of production also compares with 67,400 bbl. per day in 1941 and with a daily average of 53,500 bbl. for the 15 years preceding 1942.

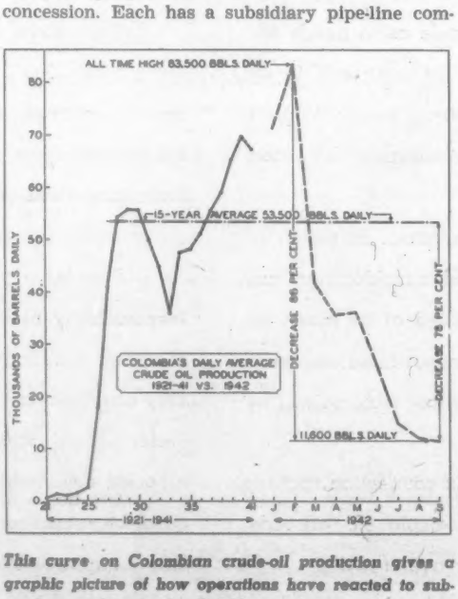
A comparison of Colombian daily average production for the first 9 months of 1942 with that of the previous 9 years follows:

	1942	Past years	
January	71,400	1933	36,050
February	83,500	1934	47,500
March	41,800	1935	48,200
April	35,750	1936	51,250
May	36,200	1937	55,600
June	26,200	1938	59,000
July	15,000	1939	65,400
August	12,100	1940	69,800
September	11,600	1941	67,400

Colombia's Economy Affected

The effect of this change has not been so severe on Colombia's economy as it has been in those countries where oil is the dominant industry. In Colombia, the government royalty on oil production amounts to 10 per cent. With production in recent years averaging around 20,000,000 bbl. and with the price of the crude oil averaging, roughly, $1 per barrel, the state revenue from the industry has amounted to approximately $2,000,000 annually. Since the national budget is normally about $100,000,000, it is apparent that the loss of the oil revenue to Colombia cannot be classified as a critical one.

A similar relationship obtains with respect to employment. There are only two main producing companies in Colombia, Tropical Oil Co., principally in the La Cira and Infantas fields of the DeMares concession, and Colombian Petroleum Co., principally in the Petrolea field of the Barco concession. Each has a subsidiary pipe-line company, Andian and South American, respectively. Tropical, the larger, with approximately 85 per cent of the national production, normally employs 4,000 to 5,000 workers, and Colombian, 600 to 700. A small number are also employed in the wildcat operations of the other companies. In aggregate, however, this is a very small percentage of the country's total population which exceeds 8,000,000. With operations so drastically reduced, some local problems have developed but the companies have been able to prevent any real distress among their employes and their families.


ALL TIME HIGH 83,500 BBLS. DAILY
15-YEAR AVERAGE 53,500 BBLS. DAILY
COLOMBIA'S DAILY AVERAGE CRUDE OIL PRODUCTION 1921-41 VS. 1942
DECREASE 86 PER CENT
DECREASE 78 PER CENT
11,600 BBLS. DAILY
THOUSANDS OF BARRELS DAILY
1921-1941
1942

This curve on Colombian crude-oil production gives a graphic picture of how operations have reacted to submarine warfare in the Caribbean

Internal Distribution Inadequate

Colombia has one oil problem that is quite similar to the U. S. East Coast supply problem. The country's only refinery of consequence is Tropical's 14,500-bbl.-per-day plant at Barranca Bermeja. The refinery serves the area in which it is situated by barge transportation on the Magdalena River and its tributary, the Cauca. In normal times cargoes from the port of Barranquilla where the Magdalena empties into the Caribbean are taken through the Panama Canal to supply Colombia's West Coast consuming area. This area is also supplied in part from Peru. With ocean transport no longer possible and with internal transportation facilities handicapped by lack of tank cars and the shortage of rubber, there is a deficiency of products on the West Coast and the rationing of gasoline in that region is said to be under consideration.

Complete loss of the export markets has been reflected in oil-field operations which are reported to be running below the very low 1941 rate. This does not apply to wildcat operations which are continuing though no discoveries of major importance have been made for some time.

●

Venezuela Seeking Larger Share of Petroleum Revenue

NEW YORK.—Negotiations between representatives of the oil companies operating in Venezuela and the Government by which the state hopes to obtain a "more just distribution of benefits" are now in progress.

President Isaias Medina described this objective in announcing that the Government is studying a revision of the petroleum-revenue system. The imminence of action was apparent from his statement that "before taking energetic action, we will converse with the petroleum people for the last time."

Just what form of action will be taken is not known. President Medina is reported to be opposed to the imposition of an export tax on the basis that it would be merely a transitory measure and that the Government was looking toward a more permanent arrangement. It has been suggested that this may take the form of revision of Article 21 by which certain imports of the companies are brought into the country tax-free, an increase in governmental royalties, higher concession fees or other alternatives.

President Medina is quoted as saying that "we need the help of foreign capital to develop our country but we want our just share. We do not want to attack the companies but merely to seek to secure for the Venezuelan Government and the people their fair proportion of the nations' wealth."

The president's statement is regarded as evidence that the dispute is limited to the matter of revenue and is not a preamble to some form of state regulation. The question of revenue has been a topic of considerable editorial comment in Venezuelan newspapers with agitation for action being fostered by the more liberal press.

OPC Makes Bold Bid for Role As Single Federal Oil Board

By HENRY D. RALPH

WASHINGTON, D. C.—Witnesses representing the Office of Petroleum Coordinator appeared this week before the oil subcommittee of the House to explain the current petroleum problems. OPC spokesmen made an unconcealed bid for designation as the single oil agency in Washington—with powers in its field similar to those delegated William Jeffers, rubber director.

Following a lengthy executive session Monday morning, at which many key OPC officials appeared, the committee now headed by Rep. Clarence F. Lea, of California, in lieu of Rep. William P. Cole, Jr. (resigned), held open hearings at which OPC officials again were the principal witnesses.

Deputy Petroleum Coordinator Ralph K. Davies, first OPC witness at the open hearings, asserted that "We can't restrict the public statements" on oil to releases from the OPC, but declared that as radio listeners determine on their favorite commentator for authentic news broadcasts, the oil users of the country should determine upon the OPC as the "one office, and one office only, which has the over-all facts on all petroleum supply." He said OPC was the one central agency which must aim at consolidated operation of the separate units of the industry.

Mr. Davies' statement came on the heels of reports appearing Sunday, which quoted an unnamed "high government official" as declaring that the primary reason for a breakdown in oil administration was the lack of a unified agency to head it up. Since this assertion is reported to have come from a spokesman of the War Production Board, it may be assumed that Mr. Davies' testimony was made in an effort to strengthen the position of OPC as claimant to the "petroleum czarship" which probably will be set up.

It is known that President Roosevelt has had on his desk for some weeks a proposed executive order which would make Coordinator Harold L. Ickes the petroleum chief and would shear the Office of Price Administration, Office of Defense Transportation, and other agencies of what control they now exercise over oil.

On the subject of a crude-price advance, Mr. Davies said there is a growing feeling within the industry that such an increase should be granted by OPA. Existing price levels, it was reported, are insufficient to supply the necessary incentive to either the wildcatter or the stripper-well operator. While OPC has made no definite recommendations for such a crude-price increase, he said "we think the existing price schedules should be reviewed in the light of higher production costs, taxes, and other factors." He said he has no personal conviction as to the need or lack of need for such an increase.

A later witness, E. DeGolyer, assistant deputy coordinator, said that a recommendation would be made shortly for an increase in the price of heavy California crudes, needed for industrial and bunkering oil on the Pacific Coast.

Mr. Davies said, on questioning by Rep. Pehr G. Holmes of Massachusetts, that he believed a price increase would provide a stimulant for greater oil production, but that he would not be able to say how many more barrels it would bring in.

When the witness said that about 75 per cent of all producing wells are strippers, but that they produce only 20 to 25 per cent of all oil, Representative Wolverton, who appeared to be opposed to any increase in the crude price, wondered if he were not "putting too high a premium" on stripper production, if a general price increase were granted which would apply to the rest of the industry as well—to whom it would be just so much "velvet."

Mr. DeGolyer treated production from a factual standpoint, much of which has been covered before. He said that most of the major fields of large structural types have been found and that the end of the usefulness of the reflection seismograph is in sight, but that no better method has demonstrated itself. Hence, he said, the only answer is discovery with the drill and therefore there must be more drilling.

Mr. DeGolyer related that the OPC has recommended the drilling of 16,000 wells in 1943, with the use of 1,200,000 tons of steel and other materials, but hastened to add that this "is a restricted program."

"We will strive to make it serve," Mr. DeGolyer declared, "but I must repeat that we are near the point where oil in addition to our estimated production capacity can be secured only by a direct expenditure of critical materials."

The best estimate of the cost of finding a barrel of oil up to 1938, Mr. DeGolyer said, was around 10 cents, but that it has increased severalfold today and that there has been no increase in the market price. There will have to be some added incentive, whatever it may be, he added.

Bruce K. Brown, assistant deputy coordinator in charge of refining technology, explained to the committee the many differences in refinery practice which the war's demands for specialized products has generated. Before Pearl Harbor, for instance, the production of aviation fuel was only 2 or 3 per cent of total refinery production; this has now been raised considerably, and plants are under construction which will make it 10 times the old percentages, he said.

Gulf Coast Refiners Look to South America for Crude

By W. T. ZIEGENHAIN

HOUSTON, Tex.—At least one-fourth of this country's refinery war program is concentrated among plants located on the upper Texas and Louisiana Gulf Coast.

Fully one-third to one-half of this country's capacity to produce aviation gasoline is located along the Gulf. In addition, the Gulf Coast refineries are generally being equipped to recover petroleum fractions which will enter directly or indirectly into the manufacturing of rubber alternates and TNT.

At Port Neches, Tex., the largest synthetic-rubber production program of the world is under way. The ground has been prepared, foundations laid, and some steel erected. The first 50,000-ton unit is expected to be producing finished buna-S rubber by the end of April 1943 and the second unit of similar capacity by the middle of next year. Liquefied refinery gases from at least five plants will be utilized as charging stock here. The plants include those of the Gulf Oil Corp. (148,000 bbl. crude capacity) at Port Arthur; Texas Co. (135,000 bbl.), also at Port Arthur; Magnolia Petroleum Co. (105,000 bbl.), at Beaumont; Atlantic Refining Co. (23,900 bbl.), at Atreco, and the Pure Oil Co. (48,700 bbl.) at Smiths Bluff, all in Texas.

Near Houston, another 50,000-ton unit is being erected by Sinclair Rubber, Inc., and practically joins the Sinclair Refining Co. plant there. Ground has been prepared and some foundations and steel are in place. Production is expected in the fall of 1943. Still another synthetic unit of major proportions, now under construction, is that of Cities Service at Lake Charles, La. This is being constructed along with the company's new 55,000-bbl. refinery and the entire job is planned for completion in the late summer of 1943.

In addition to these major construction programs, most readers are aware of the present and expanding production of synthetic-rubber components in the Gulf Coast subsidiary plants of the Standard Oil Co. (New Jersey) namely, that of the Humble Oil & Refining Co. (185,000 bbl.) at Baytown and the Standard Oil Co. of Louisiana (120,000 bbl.) at Baton Rouge.

At present, the bulk of the nation's aviation-gasoline production, in excess of 100,000 bbl., is being produced daily along the Gulf Coast. Production will be further expanded as the need arises. In addition, large quantities of toluene are being produced there and this too is expected to increase. So, to make these products alone, it is necessary to crack or reform the normal gas oil and light-distillate yield as well as to make a close selection of preferential crudes.

Normally, Gulf Coast refiners produce about 43 per cent motor gasoline from the crude they refine, but under the present war program the

(Continued on Page 181)

Opponents Continue Fight for Delay in Gasoline Rationing

OPPONENTS of nation-wide ratoning this week continued their relentless attack against the program. But federal bureaus, chiefly the Office of Price Administration and the Office of Rubber Administration, went ahead with plans to limit all nonessential automobiles to a basic motor-fuel quota of 4 gal. per week, effective December 1.

Attacks against the rationing program centered in the southwestern oil area but support was volunteered from practically every state west of the Alleghenies. Post cards, letters, telephone calls and telegrams flooded offices of governors in unrationed states, Senate and House offices in Washington and direct appeals for postponement or modification went direct to Leon Henderson, William M. Jeffers, Joseph B. Eastman, federal directors respectively of prices, rubber and transportation. Some of the protests went to the highest authority in the land, the White House.

A bloc of more than 200 representatives, called to caucus at Washington by Rep. Jed Johnson of Oklahoma, instructed spokesmen to protest the rationing program with Messrs. Henderson and Jeffers. At midweek, however, there appeared slight prospect that the time table of nation-wide rationing could be further delayed. Federal bureaus had a "face saving" stake in the outcome and for that reason, if no other, it seemed to observers that Messrs. Henderson and Jeffers could ill afford to retreat. Three resolutions for 90-day postponement are pending in Congress.

Mr. Jeffers repeated findings of the Baruch committee regarding the absolute necessity of limiting mileage for nonessential driving in order to maintain operation of the nation's automobiles until synthetic-rubber production is available.

Postponement Hopes Raised

Hopes of rationing opponents were stimulated a week ago when one of the junior executives of the OPA hinted that fuel restrictions are necessary in order to increase overland movement of petroleum products to the East Coast. This statement was seized upon as disclosing the "true reason" for rationing. Tempo of protests increased, pointing out that all areas outside the East Coast states are abundantly supplied with gasoline and that voluntary restrictions on driving had already accomplished the rubber-saving objectives. While not retracting the statement concerning the objective of increasing petroleum shipments to the eastern seaboard, the OPA hastened back "on the beam" and clung to the argument that rationing is strictly a mileage-conservation measure.

A majority of the nation's drivers outside the previously-rationed East Coast registered for their A books last week end. Hundreds of motorists, however, apparently confident that postponement would be ordered at the eleventh hour, neglected to register. Some local and state boards held registration privileges open beyond the specified 3 days but in other communities the rolls were closed promptly and posed a problem for rationing authorities.

While the rationing question settled down to a decisive struggle between representatives of the public and government administrators, broad testing operations with tubeless tires were continued by oil companies. More than 1,000 oil-company automobiles scattered throughout the country were converted to tubeless-tire operation on recommendation of the Petroleum Industry War Council. Arrangements for the tests were completed November 10. Data are not yet available on results of the experiments. Sponsors are confident that findings will confirm practicality of the proposal.

Many participants in the fight against rationing conceded that the outlook is dark for postponement but opposition is being pushed all the more vigorously because of the possibility that modification may be ordered after the plan is in operation for a limited period. Opponents are confident that trial of the rationing plan will prove their point that driving restrictions in the western parts of the country impede the war-production program and will be, therefore, of short duration.

Texas Starts Tubeless Tests

State-owned cars in Texas are being used to test the tubeless tire following a demonstration by John B. McGay and Victor Barnett of Tulsa before Gov. Coke Stevenson of Texas. After the demonstration, Governor Stevenson ordered a number of state Highway Department cars in representative sections of the state to be equipped with one or more tubeless tires so that the idea might be adequately tested in a short time. Thus, the discovery will be tried under a great variety of climatic conditions.

Governor Stevenson, a rabid opponent of gasoline rationing, indicated that in case the method proves feasible he will bring as much pressure as possible to bear on the national administration to accept it and modify the present regulations on car use.

During the week, Governor Stevenson hit back at Rubber Administrator Jeffers for the statement made at New York that the "opposition to gasoline rationing was being financed by people who should know better." Texas' governor said that Mr. Jeffers was not telling the truth because of the thousands of letters coming into the executive office, 99 per cent were from people unable to finance such a campaign. These people, the governor said, are honestly trying to make a living and at the same time support the war program. They feel that rationing will hinder their efforts.

Another blast at Jeffers was delivered in a telegram by John L. Smith, lieutenant governor-elect, who pointed to the surplus of gasoline in Texas, the fact that practically everyone in the state is conserving rubber by reduced speeds and mileage, and that the rationing as proposed is so severe that it will badly cripple economic life and hurt the war effort.

The general concensus in Texas and other southwestern states was that chances are 50-50 for postponement.

While oil companies have been assured by some rationing authorities that gasoline and tires would be forthcoming, many were extremely doubtful due to past experiences with local boards. In the final analysis the local boards are the deciding factor. In numerous instances the local rationing board do not follow the general rules emanating from Washington. For instance several companies reported that when they put their best foot forward and applied for tires for cars and trucks used in geophysical work they were rejected by the local boards.

Five Key Executives With Jersey Company Promoted

FIVE top executives of Standard Oil Co. (New Jersey) were promoted this week and assigned new responsibilities in a general upgrading of officials caused by retirement of Walter C. Teagle, chairman; E. J. Sadler and D. L. Harper, vice presidents, all members of the board.

Ralph W. Gallagher, vice president and director of the Jersey company for many years in charge of its natural gas operations, becomes chairman of the board. His photo and biographical sketch appear in this issue of the Journal, Page 185.

Wallace E. Pratt and E. Holman, both geologists and former executives of Humble Oil & Refining Co., Houston, Tex., but more recently members of the Jersey board, become vice presidents of the company filling the vacancies caused by promotion of Mr. Gallagher and retirement of Mr. Harper.

Frank Pierce, executive assistant to the president and manager of the industrial relations department, and R. T. Haslam, assistant to the president, handling special work related to synthetic rubber and aviation gasoline, become members of the board.

Messrs. Teagle, Sadler and Harper had reached the retirement age and decided to relinquish active management responsibilities to their younger successors.

WALTER C. TEAGLE *E. J. SADLER* *E. HOLMAN* *W. E. PRATT*

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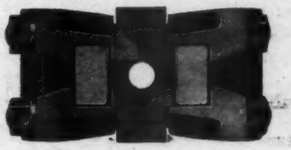

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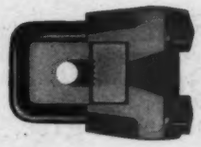

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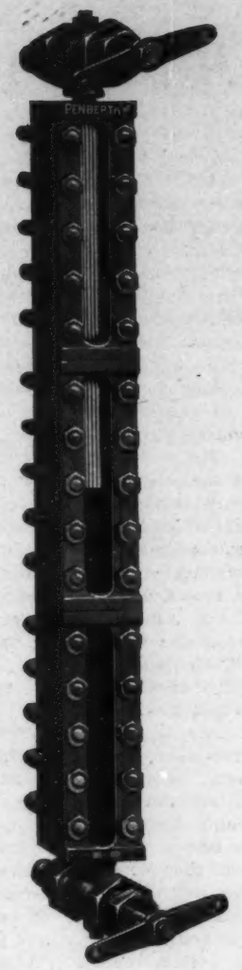

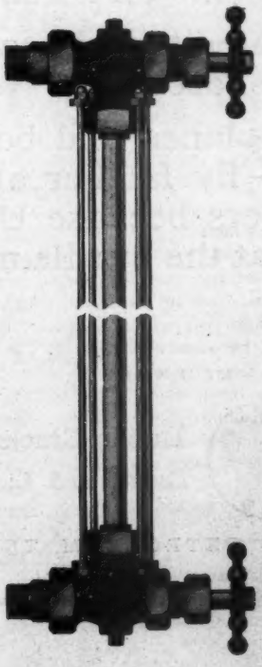

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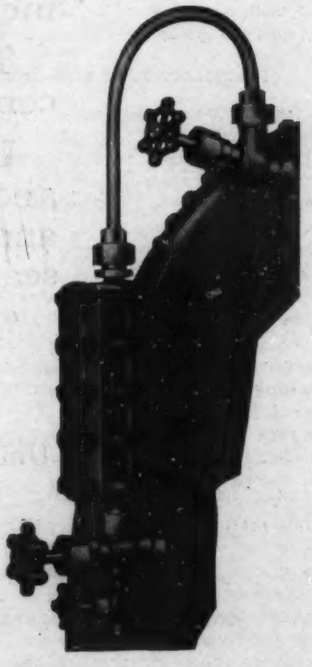

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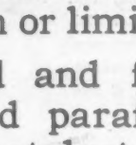

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Ipatieff, Catalysis Authority, Honored at Chicago Dinner

CHICAGO.—Dr. and Mrs. V. N. Ipatieff, the former world known as a foremost authority on catalytic reactions, were honored by a dinner at the Adventurers Club here last week on the occasion of his seventy-fifth birthday anniversary, his fiftieth anniversary in chemistry, and their golden wedding anniversary. The dinner was attended by leaders in American chemical research who recounted outstanding events in Dr. Ipatieff's scientific and personal career.

A group of well-known scientists and industrial leaders attended the dinner at the Adventurers Club, Chicago, November 20, honoring Dr. and Mrs. V. N. Ipatieff, world-famous authority on catalysis and high-pressure chemical reactions. The guests are, left to right: J. G. Alther, vice president, and H. J. Halle, president, Universal Oil Products Co.; Dr. Gustav Egloff, Universal's research director; Dr. Frank C. Whitmore, professor of organic chemistry, Pennsylvania State College and ex-president American Chemical Society; Dr. Vandeveer Voorhees, Standard Oil Co. (Indiana), chairman of the meeting; Dr. V. N. Ipatieff, Universal's chemical research director; Mrs. Ipatieff; Dr. Ward V. Evans, professor of organic chemistry at Northwestern University

Born in Russia, Dr. Ipatieff was at the turn of the century already a well-known researcher in catalysis. During World War 1 he was a brigadier general in the czarist army in charge of all chemical research. As part of that work he investigated the combustion of explosives at pressures up to 4,500 atm. (67,500 lb. per sq. in.), which was his introduction to high-pressure reaction to which field much of his life's work has been devoted. A leader in the Russian Academy of Sciences, he was expelled from that body when he decided to become an American citizen and to remain in this country. He was elected to the American Academy of Sciences a few years ago, and was given the Willard Gibbs Medal in 1940, for meritorious accomplishments in chemistry.

Among Dr. Ipatieff's notable achievements in chemistry which affect profoundly our present activities in war and peace are:

Discovery in 1903 of the dehydration-dehydrogenation-polymerization reactions on ethyl alcohols which resulted eventually in the production of synthetic rubber from alcohol, now employed in Russia to produce 100,000 tons of butadiene annually.

Ethylene produced by this reaction is also important, with the phosphoric acid catalyst developed by him, in synthesizing styrene, ingredient of synthetic-tire rubber.

Discovery of high-pressure decomposition-hydrogenation reactions on which German coal and oil hydrogenation processes are now based; Dr. Ipatieff's discovery of these reactions antedates the German developments by some 7 years.

Discovery of the polymerization reaction, using a phosphoric acid catalyst, which has resulted in construction of a hundred plants using this process for making improved motor fuels, and for making codimer which is hydrogenated to produce 100-octane-number aviation-fuel components.

Discovery of the reaction of alkylating olefins with isoparaffins which is now producing a large proportion of our aviation superfuels. This is one of the first major reactions discovered which proves that paraffin hydrocarbons are less inert chemically than had been believed formerly.

Among other contributions which Dr. Ipatieff has made to the country of his adoption—in which at the age of 64 he started anew his research activities—is the establishment and endowment of a laboratory at Northwestern University for chemical research, to which he has donated $26,000 of his personal funds. He has also established a trust fund of $35,000 from the income of which, after his death, prizes are to be allotted to outstanding chemists, under the jurisdiction of the American Chemical Society.

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District 2 Refiners Asked To Reduce Gasoline Yields

ST. LOUIS, Mo.—Petroleum refiners located in District 2 at a meeting held here Monday, November 23, were asked to adjust their plant operations to conform to a recent directive of the Office of Petroleum Coordinator. With July 1 to October 1, 1941, as the base period, refiners in the district were directed to reduce their runs to 90 per cent and to reduce their gasoline yields to 75 per cent of the base period.

Refiners in the district for some time have reduced their gasoline yields to 80 per cent of normal. The additional reduction of 5 per cent is asked in order to increase the yields of distillate and fuel oil. The directive does not apply to refineries engaged in the manufacture of war products.

Committees were appointed to study the effect of this latest revision in refinery operations on gasoline quality and the costs of operations. Approximately 50 refiners from all parts of the district attended the meeting. Paul Blazer, president of Ashland Oil & Refining Co., Ashland, Ky., and chairman of the refinery committee for District 2, presided at the meeting.

OPC Lowers Southwestern Quota, Raises California

WASHINGTON, D. C.—An increase of 33,000 bbl. in the California daily production quota for December and a reduction of 39,100 bbl. in the average output for the five southwestern states composing District 3 were the outstanding changes recommended by the Office of Petroleum Coordinator for next month's operations.

Indicated increases in productivity in the three District 1 states resulted in an advance of 1,900 bbl. in the daily OPC quota while a decline of 11,300 bbl. in District 2 reflected an opposite trend in output.

A production rate of 4,015,900 bbl. daily of all petroleum liquids was certified to the various petroleum-producing states for December, a reduction of 15,500 bbl. from the November allocations. Actual production of all petroleum liquids in December 1941 averaged 4,334,900 bbl. daily, or 319,000 bbl. greater than certified by OPC next month. State quotas follow:

RECOMMENDED PRODUCTION RATES

(Barrels per day)

District and state—	Dec. 1942 total petroleum liquids	Nov. 1942 total petroleum liquids	Dec. 1941 actual prod. total petroleum liquids
District 1			
New York	15,400	15,100	15,100
Pennsylvania	50,700	50,500	50,700
West Virginia	17,000	15,600	15,500
Total District 1	83,100	81,200	81,300
District 2			
Illinois	274,100	280,900	402,600
Indiana	17,700	18,400	18,600
Kansas	300,700	300,700	262,100
Kentucky	14,200	13,600	13,700
Michigan	63,800	64,500	57,000
Nebraska	3,400	3,400	5,100
Ohio	10,300	10,400	10,500
Oklahoma	403,900	407,500	452,600
Total District 2	1,088,100	1,099,400	1,222,200
District 3			
Arkansas	77,300	77,200	76,700
Louisiana	326,100	333,800	366,600
Mississippi	50,000	50,000	70,500
New Mexico	99,700	100,600	116,300
Texas	1,350,400	1,381,000	1,618,900
Total District 3	1,903,500	1,942,600	2,249,000
District 4			
Colorado	7,000	7,000	6,100
Montana	24,700	24,800	22,100
Wyoming	94,500	94,400	84,800
Total District 4	126,200	126,200	113,000
District 5			
California	815,000	782,000	669,400
Other	.....	.....	200
Total United States	4,015,900	4,031,400	4,334,900

Stock and Supply Position of Rubber Reviewed by Jeffers

WASHINGTON, D. C.—Rubber Director William M. Jeffers and members of his staff Tuesday gave the House petroleum subcommittee current figures on stocks and supply prospects of natural and synthetic rubber.

L. D. Tompkins, assistant deputy director in charge of operations, said the stocks of natural crude held by the United Nations on October 31, 1942, was 670,000 tons, of which 465,323 tons were in the U. S. Government stock pile. The United States portion is being used for all purposes at the rate of 30,000 tons per month, but this may decline unless there are unusual military demands because of substitution of reclaim and synthetic.

Imports were 7,000 tons in September but other recent months have averaged about 2,000 tons. Prospects for imports during 1943 are 35,000 to 50,000 tons, primarily from Brazil and Ceylon.

Scrap rubber in the government stock pile October 31 totaled 587,000 tons, not including scrap still in dealers' hands. Production of reclaim is currently about 25,000 tons per month and by the first quarter of 1943 it will reach capacity of about 30,000 tons per month. Additional scrap is coming in about half as fast as it is being used.

More than 5,000,000 tires have been turned in by motorists as of Tuesday and collections will continue until December 1. Many of these are used. An inventory of new unmounted tires in dealers' hands is being taken and will be completed by January 1, but estimates are that not more than 6,000,000 such tires are available.

Col. Bradley Dewey, deputy director, said that all types of synthetic rubber are now being produced at the rate of 1,500 tons per month but would be larger except for shortage of butadiene. Plants are under contract to produce 533,000 tons of butadiene annually and 210,000 tons of styrene which are from 2 per cent to 80 per cent completed. All plants are scheduled for completion between January and October 1943, but will require weeks of shakedown operation before producing at capacity. Sufficient copolymerization capacity is under construction and it may prove to be excessive. An optimistic estimate is that production of all synthetics in 1943 will be 350,000 to 400,000 tons and 800,000 tons in 1944, but production the first half of 1944 will not exceed 50,000 tons.

Colonel Dewey said the low spot is the fall of 1943, when stocks will be within 10,000 or 15,000 tons of bankruptcy and will face disaster unless the synthetic plants come into production as hoped. It is necessary to keep at least 100,000 tons of crude rubber in inventory because it cannot be replaced with synthetic for certain military uses. Based on the Baruch estimate of demand, the dangerous position will be next fall if anything goes wrong, but for 1944 the picture is optimistic and civilians should get synthetic tires by the spring of 1944.

Colonel Dewey said the Houdry butane process for making butadiene is being seriously studied for use in five other plants, but was recently disapproved for Oklahoma because the proposed location was too far from copolymerization plants.

Director Jeffers said the synthetic program he inherited is technically sound but he found it necessary to reorganize its administration from top to bottom.

He said Colonel Dewey was too optimistic in forecasts of 1943 production and that if the new plants and processes develop troubles which delay capacity production the nation will be in a serious situation next fall, so it is absolutely essential that present tires be conserved.

Gasoline rationing must go into effect as scheduled, Mr. Jeffers insisted, in order to protect essential driving such as getting people to work and maintain farm production. He said he had not anticipated so much opposition to gasoline rationing, and he denounced what he described as an organized campaign against it financed by unidentified parties "who should know better."

Under questioning by the committee, Mr. Jeffers insisted gasoline rationing is the only practical device for controlling use. There is an absolute present need for limiting driving until it can be seen how much and how soon the synthetic plants will produce, he declared, because it is a gamble.

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Lucas Medal Awarded J. R. Suman For Achievement in Production

NEW YORK.—John Robert Suman, vice president of Humble Oil & Refining Co., Houston, Tex., has been awarded the Anthony F. Lucas Gold Medal for 1943 by the American Institute of Mining and Metallurgical Engineers for his "distinguished achievement in improving the technique and practice of producing petroleum."

The Anthony F. Lucas award for 1943 was made on the recommendation of a special committee of 16 leaders in the petroleum industry of which J. Terry Duce, director, Foreign Division, Office of Petroleum Coordinator, Washington, D. C., is chairman. Previous recipients of the medal have been J. Edgar Pew, vice president, Sun Oil Co., Philadelphia; the late Henry L. Doherty, president, Cities Service Co., New York; E. L. DeGolyer, assistant deputy coordinator, Office of Petroleum Coordinator, Washington, D. C.; and Marcel and Conrad Schlumberger (jointly) of Paris, France.

In 1941 Mr. Suman was elected to the presidency of the A.I.M.E. For many years he has been identified with the technical activities of the American Petroleum Institute. In 1942 he was awarded the honorary degree of Doctor of Science by the South Dakota School of Mines, Rapid City.

DEATHS

CHESTER D. WOMMER, 61, oil producer of Pennsylvania, died last week at his home in Oil Valley. His widow survives.

GEORGE SELDEN HENRY, independent oil operator of Tulsa, was killed when an automobile he was driving crashed into a bridge abutment near Ovalo, Tex. Mr. Henry was formerly connected with Keener Oil Co.

FRANCIS HARVEY PAYNE, 74, president, American Meter Co., and manager of the corporation's Metric Metal Works plant at Erie, Pa., died suddenly November 10, while attending a club meeting. A native of Pennsylvania, Mr. Payne entered the gas-meter business in 1891, when he became secretary and manager of Metric Metal Co., then at Beaver Falls, Pa. For 52 years he managed this factory, which became a part of American Meter Co. when that company was organized in 1895. He was a director of this corporation for many years prior to his election as vice president in 1923, and as president in 1936. His widow and two sons survive.

JOHN J. FITZGERALD, 59, for 34 years an employe of Carter Oil Co., eastern division, and Hope Construction & Refining Co., died November 1, at his home in Pittsburgh, Pa., after an illness of 6 weeks. Mr. Fitzgerald was born in Wooster, Ohio, and after a course in business training, was employed by the late Charles G. Carter, son of Col. John J. Carter, founder and president of Carter Oil Co. He was secretary and assistant to three successive vice presidents of Carter Oil Co., eastern division. His widow, a son and a daughter survive.

BENNET B. BRISTOL, 64, who with his brother, Edgar H. Bristol, founded the industrial Instrument Co., in 1908, died at his summer home at Falmouth Heights, Mass., November 10, following a lengthy rest from a heart attack. Throughout the history of Foxboro Co., he served as its treasurer and clerk. His widow and six children survive.

FRANK J. WESCHLER, vice president of Chain Belt Co., Milwaukee, Wis., and general manager of Baldwin-Duckworth, a division of Chain Belt at Springfield and Worcester, Mass., died suddenly November 10, in Worcester. Mr. Weschler had been a vice president of the Associated Industries of Massachusetts, a director of the Chamber of Commerce, and had been director in several banks.

W. G. CLAYTON, 72, pioneer Oklahoma oil man, died last week in a Tulsa hotel after a short illness. Mr. Clayton, who lived in Barnsdall, Okla., had been connected with the oil business for 57 years. His widow and four daughters survive.

DR. FREDERICK L. THOMSON, 68, oil man of San Antonio, Tex., died November 17 in his home in that city, where he had resided 26 years. After graduating from the University of Montreal Medical School, Dr. Thomson, a native of Canada, studied medicine 4 years in the College of Edinburgh, Scotland. He retired from his practice in San Antonio to give his time to oil operations in which he was becoming increasingly interested. At one time he was president of Grayburg Oil Co. He leaves his wife; a son, Frederick L. Thomson, Jr., Fort Worth, Tex., and a daughter, Mrs. Aben Stiles, Maracaibo, Venezuela.

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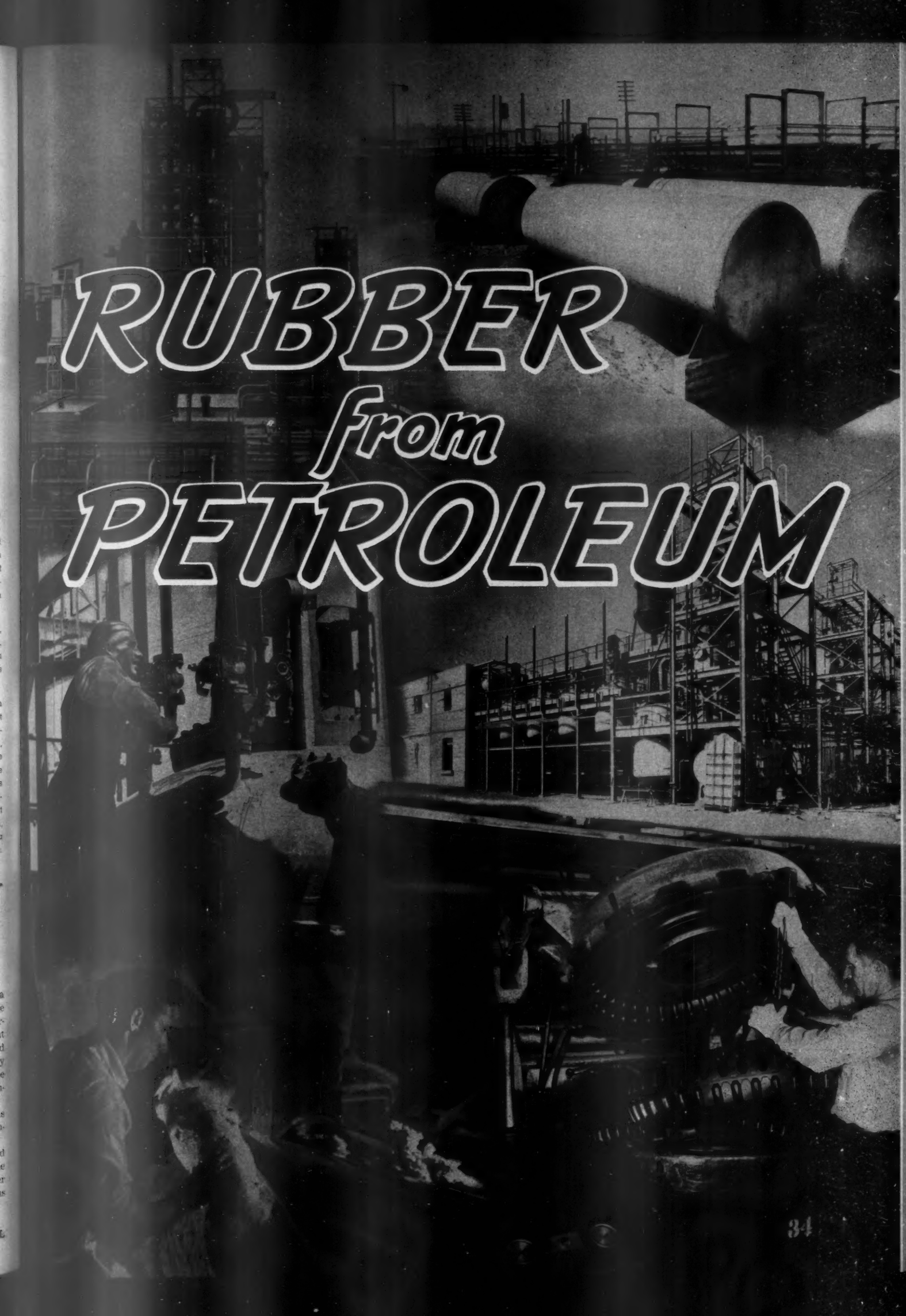
Natural Gasoline

Illinois, Oklahoma, Panhandle Chief Factors in Higher Yield

Production of natural gasoline increased to a daily average of 233,000 bbl. in September, the Bureau of Mines reported last week. Daily average yield in August was 227,000 bbl. and output for the first 9 months this year has averaged 226,000 bbl. Current production, substantially higher than during the second quarter of the year, is slightly below the record output in January and February.

Increases in Illinois, Oklahoma and the Texas Panhandle were chiefly responsible for the increase in September.

The demand for natural gasoline continued strong and stocks declined again during the month to a total of 254,352,000 gal. on September 30 compared with 269,010,000 gal. the previous month.


RUBBER
from
PETROLEUM

The ABC of the Synthesis o

This article is written for the oil layman and the technologist who is not familiar with the fundamental steps involved in the all-important national job of producing rubber in our emergency, who is not interested in all the details but wishes to know something of the important methods by which the "Rubber of Tomorrow" is synthesized.

THE manufacture of synthetic rubber, in the quantities and with the qualities required by our national wartime demands, we believe can rightly be considered the greatest single effort ever made by the human race under conditions of stress and national peril. From the production of specialty synthetic rubber under severe peacetime competitive conditions, manufactured for special purposes with certain properties accentuated and improved beyond those obtainable in natural rubber, in small quantities of several thousand tons per year, we are forced overnight to undertake the production of a highly specialized product from available materials involving a series of extremely complicated chemical reactions and industrial processes, with the yield in terms of a million tons per year. At the same time we are forced to train thousands of workmen, executives and administrative personnel in the "know how" of a science and an art with so few people acquainted with that knowledge that we do not have enough instructors to handle the pedagogical problem. Simultaneously we must produce carefully designed and fabricated equipment of relatively enormous capacities when our only experience has been with small-sized equipment carrying out the same processes.

Similarly we must produce the raw materials—steel, iron, copper, brass, aluminum, platinum, etc.—in hitherto unheard of quantities, at a time when existing facilities for this production are taxed to the utmost to supply the emergency demands for the greatest, most involved, mechanized war of all time. We must prosecute that war with inadequate available supplies of everything from soldiers to shaving soap, all at the same time. Never in history has a people faced a more apparently insuperable task that it is not insuperable and that it is being done speaks volumes for the national health and energy of our own people.

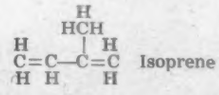
This article is written for the oil layman and the oil technologist who is not directly involved in the manufacture of synthetic rubber or its component intermediates; the man who is not interested in following out all the exhaustive details so important to the rubber synthesist, yet who wishes to have a general over-all picture of the process by which synthetic tires will appear from hydrocarbon gases, coal tar and field corn to serve his transportation needs. It does not attempt to enlighten the reader on all the ramifications of different types of rubber to differentiate between them in detail; or to present a flow chart of the several processes by which each step may be carried out to form each component material. Those meticulous discussions are reserved for the technical articles included in this symposium.

This butadiene unit is one of the pioneers, one of the first to get into production making butadiene for our war rubber program. Many other units for the same purpose are under construction and many of the design data on which plans are based were obtained from the operation of early units like this one

Early History of Rubber

All have been informed, in some cases misinformed, about the early history of natural and in some measure of synthetic rubber. The first recorded history of rubber is that of any early explorer who found South American Indians playing a game with black, resilient, somewhat sticky balls which bounce when directed against a solid object. This was unvulcanized rubber and to civilization was essentially useless as such. The inquisitive mind of a Yankee, Goodyear, a century ago led him to scramble crude rubber and sulfur, after trying innumerable other combinations; forgotten on the kitchen stove a troublesome mess was created—also the modern rubber industry. The crude sulfur-treated product was tough, resilient durable; vulcanized rubber.

The trained curiosity of the British chemist Williams found 20 years later that rubber is formed apparently by the multiple polymerization—adding together two or more similar molecules to form a new molecule—of isoprene, a five-carbon molecule of the formula as follows:

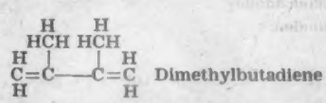


Isoprene

Chemists continued to attack the rubber molecule with indifferent success, and today we know relatively little about the actual construction of rubber beyond the fact that it is a product of polymerization of apparently thousands of these peculiar units. Many theories have been advanced to explain rubber's specific properties but none has been proved conclusively.

World War 1 Experience

The first serious effort to produce rubber synthetically on a large scale came during World War I when a German, Fritz Hoffman, polymerized a "cousin" of isoprene, dimethylbutadiene.



Dimethylbutadiene

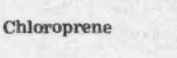
This product was used to make battery jars for submarines, for electrical and other essential equipment, but was decidedly unsatisfactory. The imperial limousine of Kaiser Wilhelm, equipped with a set of tires from this source, had to be placed on supports each night to take the weight off the tires, which otherwise developed perma-

# of Rubber

nent flat spots, before morning, where they rested on the garage floor. After the war, German and other scientists continued to study the synthesis of rubber with some success, the Germans developing the buna-type rubbers, the counterparts of which are being produced in this country with numerous variations and many important improvements.

First Important Development

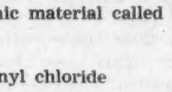
The first important synthetic-rubber development in this country came several years ago, made by Du Pont from a derivative of isoprene, wherein one CH_3— group is replaced by a chlorine atom.



Chloroprene

This product, called neoprene, has been used widely for some years, especially in the manufacture of gasoline and oil hose and in household and industrial rubber products where strong resistance to the action of solvents is needed.

Later other products, such as Koroseal, made by polymerizing an organic material called vinyl chloride,



Vinyl chloride

were perfected. Koroseal was first merely a hard, tough, unworkable solid until treated with an organic solvent in an attempt to remove the chlorine, whereupon Dr. W. L. Semon, Goodrich scientist, now one of the leaders in rubber synthesis, was amazed to find a resilient tough product which has since been employed in large

Dr. Per K. Frolich, research director for Standard Oil Co. of New Jersey, and a leading American authority on synthetic-rubber manufacture, demonstrates the property of stretchability of synthetic rubber before an attentive audience

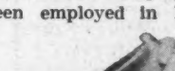
quantities for the manufacture of a great number of important products. Thiokol, now mentioned as a substitute material for tire recapping, was also synthesized by reaction of sodium polysulfide and ethylene dichloride or other similar material.

In the last 3 or 4 years several rubber companies have gone into intensive research to develop synthetic-rubber products, especially for the manufacture of specialty equipment where the improved properties of these rubbers make them a premium material for these purposes. At the outbreak of the present war the information, patents and technology of these several companies were pooled and from the combined knowledge thus made available to the chemists and engineers of the country the processes, by which we are now making rubber and by which we will provide our entire national requirements, have been developed. Prior to this pooling of interest and knowledge in this emergency several companies had produced considerable quantities of synthetic rubber used for special purposes, which products, although differing in some of the "pepper and salt" chemicals and adjunctive materials used in making the finished rubber, and in routines and procedures by which the material is synthesized and processed, start from essentially the same materials.

Butadiene the Important Ingredient

For tire rubber these two materials are substances called buadiene and styrene. For specialty rubber, butadiene is combined with another organic material known as acrylonitrile, and in some cases various other materials—acrylates, methacrylates, various resins and plastics, etc.—may be added to vary the properties of the product.

The primary and all-important material in all these rubbers is butadiene.



Butadiene

Butadiene possesses what the chemists calls unsaturation, that is, it lacks the requisite number of hydrogen atoms to balance the chemical-attraction forces of the carbon atoms present; this shortage of hydrogen is indicated in the formula by double lines, called "double bonds," between carbons 1 and 2, and between carbons 3 and 4. It is the chemical properties given by these double bonds of chemical attraction, this state of unsaturation, which give to butadiene its peculiarly active properties and makes our present synthetic rubber possible.

Butadiene may be prepared by removing two pairs of hydrogen atoms from butane,

Butane

found in huge quantities in natural gases and in the same type of gases occurring in refinery vapors. This hydrogen removal may be by ther-

(Continued on Page 114)

PIWC Temporary Committee on Synthetic Rubber

First column, reading down: W. S. S. Rodgers, president, Texas Co., chairman of the committee; W. H. Ferguson, executive vice president, Continental Oil Co.; Frank Phillips, chairman of the board, Phillips Petroleum Co.; Charles F. Roeser, president, Roeser & Pendleton; R. G. A. van der Woude, president, Shell Union Oil Corp. Second column: Dr. R. E. Wilson, president, Pan American Petroleum & Transport Co.; Jacob France, president, Mid-Continent Petroleum Corp.; John A. Brown, president, Socony-Vacuum Oil Co., Inc.; Eric V. Weber, president, Eureka Oil Co.; Harry F. Sinclair, chairman of board, Consolidated Oil Corp., and William F. Humphrey, president, Tide Water Associated Oil Co. Other members are: P. C. Keith, M. W. Kellogg Co., technical adviser and consultant, and J. H. Pipkin, Texas Co., secretary of the committee

Federal Mechanism for Directing the Synthetic Rubber Program

By HENRY D. RALPH

THE synthetic-rubber program is government-financed, government-owned, and government-controlled, and its administration is in complete charge of a single government official.

Although many federal agencies have a part in various phases of the program, they all function under the direction of Rubber Director William M. Jeffers. Aided by a relatively small staff of experts and technical advisers, Mr. Jeffers coordinates the entire program, sets the policies and assigns the functions of the various operating agencies.

Organizationally, the rubber director is under the chairman of the War Production Board, to whom President Roosevelt delegated authority over all matters pertaining to rubber. Practically, however, Mr. Jeffers is top man in the whole show, for WPB Chairman Donald M. Nelson has redelegated full authority to him.

Mr. Jeffers says that the Baruch report is his "bible," and it is being accepted as gospel by the entire Government. Should a tendency toward unorthodoxy develop in any quarter, it could quickly be corrected by reference to the president's executive order which gives the rubber director, through the chairman of WPB, complete power over the program.

Because the Baruch report is being followed so closely, its recommendations give the best description of the present organization. The committee's report recommended:

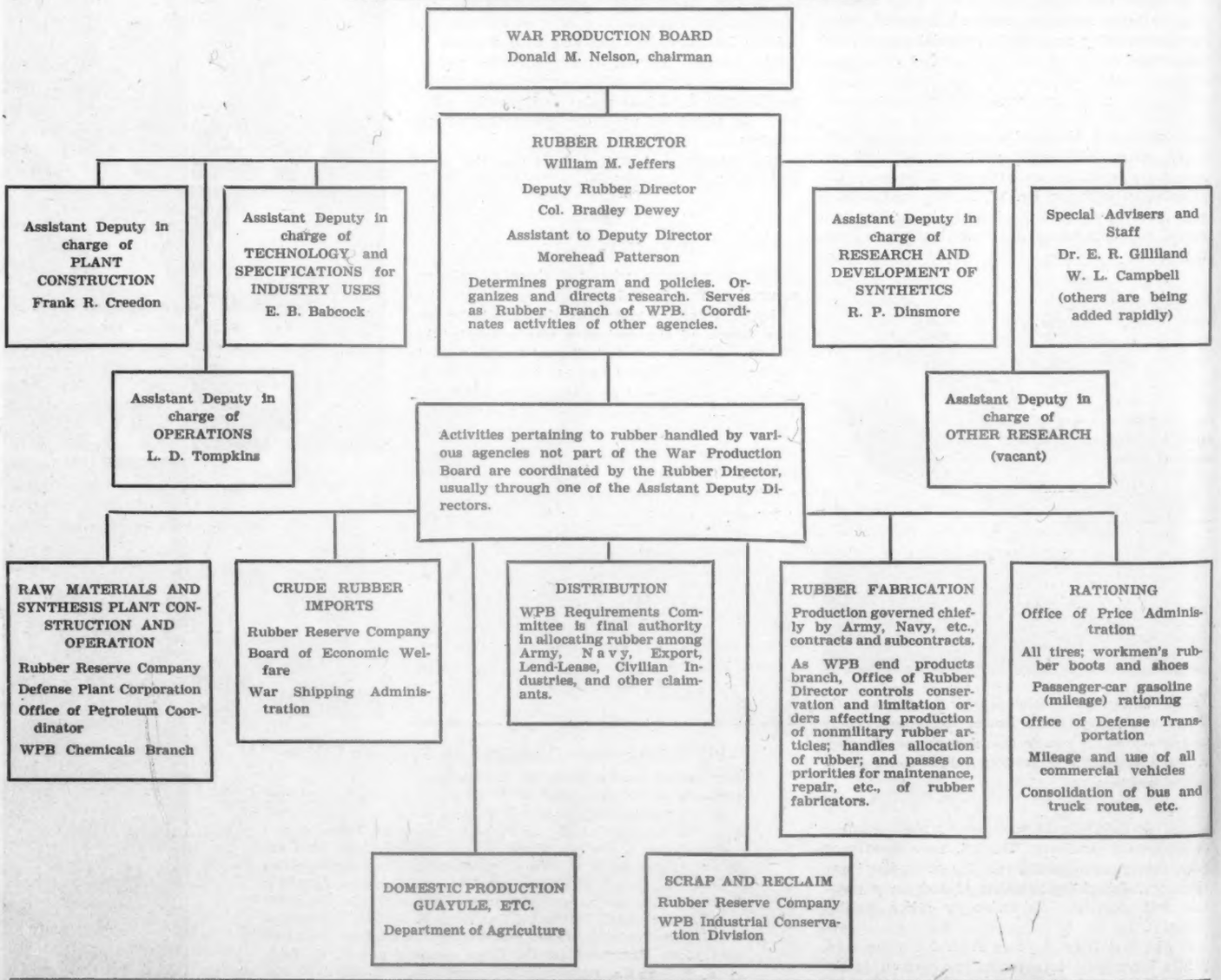
A complete reorganization and consolidation of the governmental agencies concerned with the rubber program.

(*a*) The War Production Board must assume full responsibility for the rubber program in all of its phases. We therefore recommend a directive from the president ordering the Rubber Reserve Co. and all other government agencies to act in all matters relative to the rubber program as directed by the chairman of WPB.

(*b*) To discharge adequately the responsibilities which we recommend that the chairman of WPB explicitly assume for the entire rubber program, full authority must be centered in a single official. We therefore recommend that the chairman of WPB appoint a rubber administrator and delegate to him full and complete authority in regard to the manufacture of synthetic rubber, including research, development, construction, and operation of plants.

(Continued on Page 148)

FEDERAL AGENCIES DEALING WITH RUBBER


WAR PRODUCTION BOARD
Donald M. Nelson, chairman
RUBBER DIRECTOR
William M. Jeffers
Deputy Rubber Director
Col. Bradley Dewey
Assistant to Deputy Director
Morehead Patterson
Determines program and policies. Organizes and directs research. Serves as Rubber Branch of WPB. Coordinates activities of other agencies.
Assistant Deputy in charge of PLANT CONSTRUCTION
Frank R. Creedon
Assistant Deputy in charge of TECHNOLOGY and SPECIFICATIONS for INDUSTRY USES
E. B. Babcock
Assistant Deputy in charge of RESEARCH AND DEVELOPMENT OF SYNTHETICS
R. P. Dinsmore
Special Advisers and Staff
Dr. E. R. Gilliland
W. L. Campbell
(others are being added rapidly)
Assistant Deputy in charge of OPERATIONS
L. D. Tompkins
Assistant Deputy in charge of OTHER RESEARCH
(vacant)
Activities pertaining to rubber handled by various agencies not part of the War Production Board are coordinated by the Rubber Director, usually through one of the Assistant Deputy Directors.
RAW MATERIALS AND SYNTHESIS PLANT CONSTRUCTION AND OPERATION
Rubber Reserve Company
Defense Plant Corporation
Office of Petroleum Coordinator
WPB Chemicals Branch
CRUDE RUBBER IMPORTS
Rubber Reserve Company
Board of Economic Welfare
War Shipping Administration
DISTRIBUTION
WPB Requirements Committee is final authority in allocating rubber among Army, Navy, Export, Lend-Lease, Civilian Industries, and other claimants.
RUBBER FABRICATION
Production governed chiefly by Army, Navy, etc., contracts and subcontracts.
As WPB end products branch, Office of Rubber Director controls conservation and limitation orders affecting production of nonmilitary rubber articles; handles allocation of rubber; and passes on priorities for maintenance, repair, etc., of rubber fabricators.
RATIONING
Office of Price Administration
All tires; workmen's rubber boots and shoes
Passenger-car gasoline (mileage) rationing
Office of Defense Transportation
Mileage and use of all commercial vehicles
Consolidation of bus and truck routes, etc.
DOMESTIC PRODUCTION GUAYULE, ETC.
Department of Agriculture
SCRAP AND RECLAIM
Rubber Reserve Company
WPB Industrial Conservation Division

About One-Fourth Rubber Supply Now Available

NEARLY a quarter of a million tons, or one-fourth of our requirements for rubber in 1942, is available from various sources of natural rubber not now under enemy control, trade estimates recently made reveal. A total of 233,000 tons of crude rubber per year may be obtained from several countries, including Ceylon, South America, Central America, Africa and Mexico. Receipt of these amounts of rubber will improve materially the estimates given in the Baruch report that only 53,000 tons of natural rubber imports may be expected during the 18-month period ending January 1, 1944.

With 180,000 tons of additional rubber made available to us in this manner at the end of 1942 our position and rubber stockpile will be greatly improved over figures made public earlier this year. With a like amount obtained during 1943, any delays in pushing our synthetic-rubber output into high gear will be more than offset by the increase in our national stockpile. In the Baruch report 631,000 tons of rubber are estimated as available for the period up to January first, 1944; our requirements are set at 842,000 tons for that period, demanding 211,000 tons of synthetic rubber to keep our wheels shod and operating for essential purposes only. These newer estimates indicate that this additional amount may well be made up by imports of natural rubber from sources not formerly considered important. Therefore, any additions to our rubber supply made from synthetic plants will become a buffer stockpile with the strong possibility that more material may be freed for civilian and important but less essential nonmilitary uses in this country.

In 1940, for example, the United States used 648,500 long tons of crude rubber out of a world absorption of 1,050,000 tons—some 60 per cent of the world's rubber is fabricated here. Not only does the United States depend on the rubber-tired motor vehicle for transportation to a far greater degree than any other area of the world, but we have found ways of using rubber in thousands of various products and have exported manufactured rubber goods to the rest of the world.

The scope of the rubber-goods manufacturing industry is shown by figures of the 1939 Census of Manufactures, which reveal that there were 595 establishments producing rubber goods to the value of $5,000 or more each, not counting the use of rubber by other industries such as insulated wire. These 595 establishments employed an average of 120,740 persons during the year; paid $161,409,811 in wages, and turned out products valued at $902,328,802.

While there are thousands of products vital to American industry or individuals which are best made of rubber or, to use a phrase currently in vogue, a "rubber-like substance," the chief use of rubber is, of course, tires.

A breakdown of the crude rubber manufactured in the United States in 1940 shows this:

	Per cent
Truck and bus casings and tubes	37.9
Passenger car casings and tubes	33.8
Industrial goods	11.6
Miscellaneous	7.2
Footwear	3.3
Other tires and tubes, including airplane, solid, and accessories	3.0
Farm-service casings and tubes	2.4
Drug sundries, medical and surgical goods	0.8

Figures of the U. S. Census Bureau do not tell quite the entire story because they cover only the rubber-goods manufacturing industry as such and do not include the use of rubber by the electrical, textile, and certain other industries. For 1939 these figures show that manufacturers of rubber products consumed 563,710 long tons of crude rubber and 150,917 tons of reclaimed rubber, or a total of 714,627 tons. Of the crude rubber manufactured, 442,668 tons went into tires and tubes, 19,133 tons into boots and shoes, and 101,909 tons into other products.

During the last 10 years the use of rubber by the United States has doubled. These are the figures of the International Rubber Committee on "disappearance" (manufacturers' use) of rubber by the United States in long tons.

	Crude	Reclaim
1931	350,000	123,000
1932	332,000	77,500
1933	410,000	85,000
1934	453,200	100,600
1935	491,500	117,500
1936	575,000	141,500
1937	543,600	162,000
1938	437,000	120,800
1939	592,000	170,000
1940	648,500	190,200

Trade estimates are that during 1941, even with the use of rubber in manufacturing restricted by order of the Office of Production Management during the last half of the year, the United States used 766,000 tons of crude rubber.

Practically all this crude rubber—around 98 per cent—came from the Far East. Our 1940 imports were distributed as follows:

	Tons	Per cent
British Malaya	426,563	52.24
Dutch East Indies	287,402	35.20
Ceylon	54,941	6.73
French Indo-China and Thailand	29,755	3.64
South America	11,061	1.35
Africa	6,003	0.74

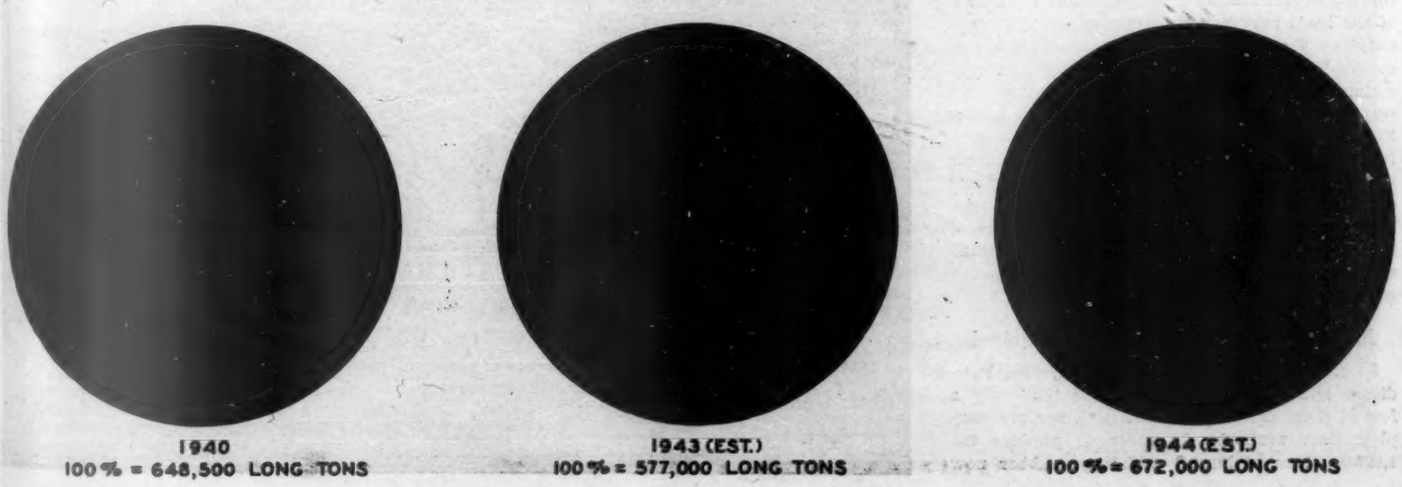
Obviously only Ceylon, South America and Africa are available to us now, and shipping from those points is menaced by Axis submarines. Moreover, the requirements of all the United Nations must be met from the crude-rubber production still outside of Axis hands.

Trade figures estimate the total production of crude rubber available to the United Nations in 1942 at: Ceylon, 109,500 tons; British India, 17,500 tons; Africa, 18,800 tons; South America, 22,700 tons; Mexican guayule, 4,500 tons; or a total of 233,000 tons.

Government officials are not saying exactly how much crude rubber has been imported this year, what is in prospect for 1943, or how the supply is being apportioned among the various United Nations. However, there is reason to believe that the trade estimates mentioned above are being substantially realized, and that while not all the rubber from Ceylon and British India, for example, is reaching the United States, it is being divided among this country, England, and Russia, and thus is serving the cause of the United Nations.

It is also no military secret that strenuous efforts are being made to expand the production of guayule rubber in the United States and Mexico, and of tree rubber throughout Central and South America. This government has made long-term contracts at attractive prices to buy all the rubber that can be produced in this hemisphere. Estimates vary greatly as to how much rubber these contracts will bring out next year or in any period in the future, but whatever the figure it is certain to be far less than our demands.

Our prewar consumption of rubber is shown at left; estimated demands for rubber in 1943 and 1944 are detailed in circles, center and right



Raw Materials for Synthetic Rubber Intermediates

By W. L. NELSON

MUCH of the confusion concerning the selection of processes for rubber manufacture is due to an incomplete understanding of the raw stocks that are available as well as argument over the merits of the many processes that may be employed. Note that Egloff and Hulla are contributing a series of articles of perhaps 60 pages, cataloging and comparing the multitude of processes and materials that may be used for the manufacture of butadiene. This series began on Page 40 of November 5, 1942, issue of The Oil and Gas Journal.

Another vital element in evaluating the amounts of basic materials that are available, is the large number of other legitimate uses for these materials as well as rubber manufacture. As a direct example, the amount of normal butane (used for butadiene) that is available in our regular motor gasoline is probably over 115,000 bbl. per day, or enough for the manufacture of more than 4 million tons of buna-S rubber per year. Yet it is obvious that all of the butane in our motor fuel cannot be used for rubber manufacture because the remaining part of the motor fuel would not be entirely suitable for our present car engines. It is also obvious that there are other important and necessary uses for butane. Much the same sort of illustration may be cited with regard to crude oil, natural gas, sugar (molasses), grains, coal, or any of the raw stocks from which synthetic rubber may be made. In short, we have heretofore been using our raw stocks, in almost their entirety, for some useful purpose, and only such raw stocks as can be spared from other uses are actually available for war or emergency purposes. Thus, a compromise among normal demands, war demands, and the demands of the new synthetic-rubber industry must be established.

In general, the main raw stocks that may contribute to rubber manufacture are shown in the following abbreviated list of materials: *Petroleum products*, natural gas, gasoline, gas oil, and fuel oil; *coal products*, coal tar, manufactured gas, and coke; *vegetable products*, grains, sugars, cellulose fibers, straw, and starches; and *mineral products*, limestone and water. Fig. 1 illustrates which of the rubber intermediates can be made from each of the basic raw materials. Operations as complicated as those involved in rubber manufacture cannot be compared with entire fairness on such a simple diagram as Fig. 1, but in a most general way, the more simple processes proceed across Fig. 1 with a minimum of intermediate products. It is interesting to note that in no instance are the ultimate rubber stocks, i.e. styrene, butadiene and isobutene, present in any natural raw stocks. The nearest approach to a natural occurrence of these ultimate stocks is their existence in small amounts in coal tar and in the cracked gas or gasoline of petroleum refineries.

Amounts of Basic Raw Stocks Required

So many methods of preparing styrene, butadiene, and isobutene are available that only a few of them can be presented here, nor are complete data available. In order to produce the 1,000,000 tons of buna-S and butyl rubber now contemplated, the following approximate amounts of the main rubber intermediates are required[1] (allowing 7.6 per cent loss in polymerizing).

	Tons
Styrene	230,000
Butadiene	710,000
Isobutene	143,000

The main source of styrene is the dehydrogenation of ethyl benzene. This material occurs in small amounts in the xylene fraction of coal tar, but it appears that most of it will be made from benzene and ethylene. The ethylene may be obtained from city gas (from coal), from the cracked gases of petroleum, or by substituting alcohol for ethylene. Benzene may also be made by the pyrolysis of petroleum products under conditions similar to those used in making coal tar or coal gas but little such benzene is being produced from petroleum at this time. One gas-manufacturing company[2] is making exceptional yields of benzene and light oils by operation on a heavy petroleum fuel oil rather than coal.

Isobutene is a constituent of the gas produced in cracking plants in petroleum refineries but much larger amounts can be obtained by the dehydrogenation of isobutane which is found in all natural gas or natural gasoline and by the isomerization of butane to isobutane followed by dehydrogenation.

Butadiene Manufacture

Butadiene is found in the cracked gases and gasoline produced in petroleum refineries, particularly in vapor-phase cracked products, but the amount is so small that economical methods have not yet been devised by which it can be extracted. The four main methods of butadiene manu-

TABLE 1—AMOUNTS OF BASIC RUBBER STOCKS

Crude oil	Over 4,000,000 bbl. per day
Natural gasoline (26-70°)	Over 130,000 bbl. per day[3]
Mixed butanes (available)*	*Over 129,000-179,000 bbl. per day[1,5]
Natural gas	Over 6,000,000 M.c.f. per day[3]
Benzene	Over 330,000 gal. per day[3] (1937)
Coal charged to coke ovens	Over 206,000 tons per day[3]
Bituminous coal production	Over 1,200,000 tons per day[3]
Wheat	Over 780,000,000 bu. per yr.[6]
Wheat requiring	Over 57,000,000 acres[6] of land
Alcohol	Over 1,000,000 gal. per day
Sugar molasses or black strap	Over 200,000 tons per year[7] (1940)

*Total in motor fuels, L. P. Gases, and wasted is 253,000-343,000 bbl. per day.

Fig. 1—(Top) Intermediates for buna-S and butyl rubber, and their sources. Fig. 3 —(Bottom) Quantities of raw materials required, and yields of rubber intermediates

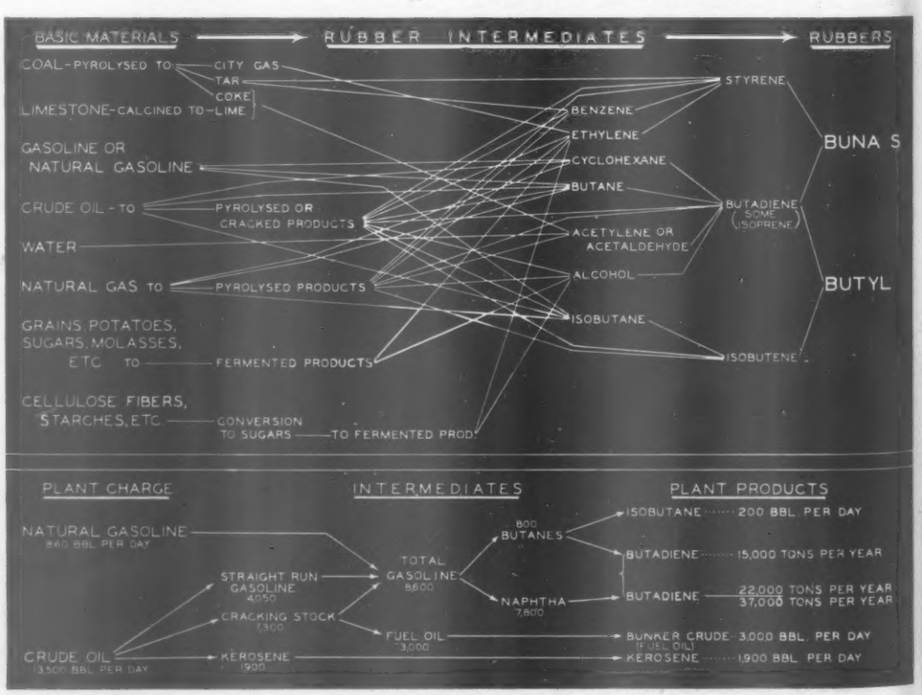


TABLE 2—PRODUCTION OF NATURAL GAS (1937)[2]

	Millions cu. ft.
California	335,000
Louisiana	320,000
Oklahoma	295,000
Texas	860,000
West Virginia	153,000
Other states	407,000
	2,307,000

TABLE 3—PRODUCTION OF NATURAL GASOLINE (1937)[2]

	Gallons
Appalachian	73,772,000
Ill., Ky., and Michigan	12,428,000
Oklahoma City	163,437,000
Seminole	121,927,000
Texas Panhandle	228,725,000
East Texas	187,713,000
Rocky Mountain	74,299,000
Kettleman Hills	177,460,000
Long Beach	83,611,000
All other districts	915,728,000
	2,039,100,000

TABLE 4—PRODUCTION OF GASOLINE (1937)[2]
(Thousands of barrels)

	St. run	Cracked	Total, incl. nat. gaso.	Approx. BPD of mixed butanes in gasoline
East Coast	33,419	46,137	81,096	22,200
Appalachian	9,911	9,666	19,939	5,450
Ind., Ill., Ky., etc.	39,482	51,850	95,409	26,100
Okla., Kans., Mo.	36,897	26,859	69,576	19,100
Texas Inland	23,043	15,532	44,391	12,100
Texas Gulf Coast	45,775	73,383	125,888	34,350
Louisiana Gulf Coast	8,477	8,737	18,049	4,950
Ark. and La. Inland	6,148	4,291	11,170	3,050
Rocky Mountain	6,860	5,778	13,464	3,700
California	41,495	25,903	79,967	22,900
Total	215,507	268,136	558,449	153,900

facture that stem from the petroleum industry are:

1. Direct dehydrogenation of butane to butadiene (the Houdry process) with yields of 67 per cent, or a modification by which gas oil or fuel oil is cracked for the production of butane and butene which is then dehydrogenated.

2. Direct production of butadiene from naphtha (raw gasoline) or gas oil by pyrolysis or cracking at exceedingly high temperatures. Yields of 3 to 9 per cent have been reported.

3. High-temperature pyrolysis of natural gas to produce acetylene, thence to acetaldehyde and butadiene. Yields of about 2.5 per cent of acetylene on a gas volume basis have been produced.

4. Conversion of ethylene (from cracked gases or by the dehydrogenation of the ethane in natural gas) into alcohol, and then into butadiene. Yields of about 20 per cent based on ethane are reasonable.

Alcohol is converted directly to butadiene at yields of 20-30 per cent but it should be noted that alcohols can be made more cheaply from petroleum gases than from grains. The acetylene process mentioned above can also be based on calcium carbide but the enormous amount of electrical power required to produce the carbide has thus far been an unsurmountable obstacle.

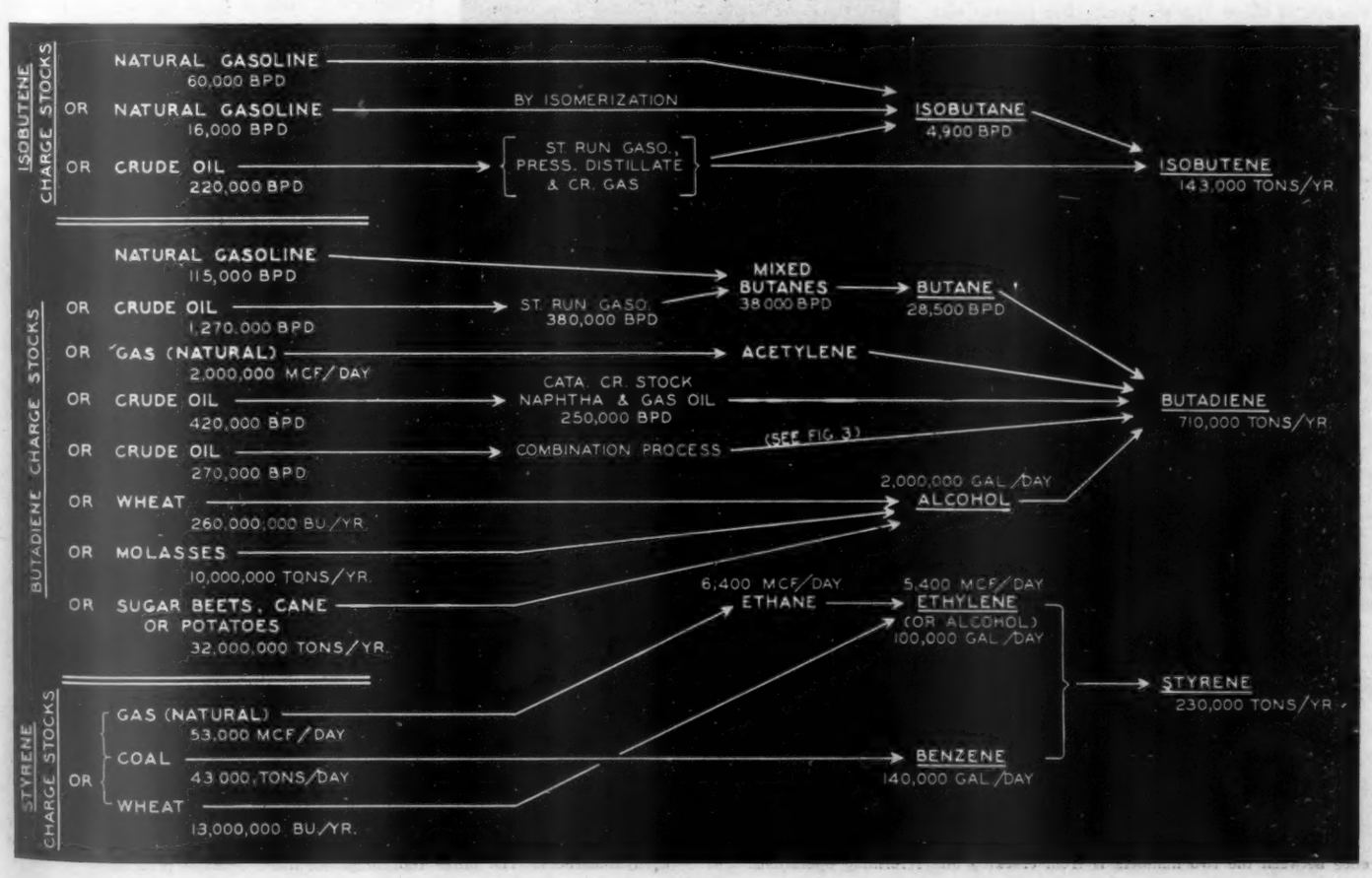
The approximate amounts of the basic raw stocks required for the manufacture of styrene, butadiene, and isobutene are indicated in Fig. 2. In each instance it is assumed that all of the rubber stock is made from the raw material designated. Alcohol yields from grains, etc., were taken from Nash and Howe, Principles of Motor-Fuel Preparation, Page 484, Vol. 1, 2nd Ed., John Wiley & Sons. Examination of Fig. 2 indicates that petroleum products can be used to supply the entire rubber program except perhaps for the benzene used in making styrene. The total of about 130,000 bbl. per day of 26-70 natural gasoline, plus 53,000,000 cu. ft. per day of natural gas will suffice, or by other methods, from 270,000 to 1,300,000 bbl. per day of crude oil will be required. Unless unannounced methods are now available, it appears that essentially all of the isobutene must be made from petroleum products, and essentially all of the benzene must come from coal tar or coal (43,000 tons per day).

A further vital consideration is the amounts of various basic materials that are being, or have been, produced.

Many of these figures (Table 1) date back to

(Continued on Page 120)

Fig. 2—Rubber intermediate raw material required for present synthetic-rubber program


ISOBUTENE CHARGE STOCKS
NATURAL GASOLINE 60,000 BPD
OR NATURAL GASOLINE 16,000 BPD
BY ISOMERIZATION
OR CRUDE OIL 220,000 BPD
ST. RUN GASO., PRESS. DISTILLATE & CR. GAS
ISOBUTANE 4,900 BPD
ISOBUTENE 143,000 TONS/YR
BUTADIENE CHARGE STOCKS
NATURAL GASOLINE 115,000 BPD
OR CRUDE OIL 1,270,000 BPD
ST. RUN GASO. 380,000 BPD
MIXED BUTANES 38,000 BPD
BUTANE 28,500 BPD
OR GAS (NATURAL) 2,000,000 MCF/DAY
ACETYLENE
OR CRUDE OIL 420,000 BPD
CATA. CR. STOCK NAPHTHA & GAS OIL 250,000 BPD
BUTADIENE 710,000 TONS/YR
OR CRUDE OIL 270,000 BPD
COMBINATION PROCESS
(SEE FIG. 3)
2,000,000 GAL./DAY ALCOHOL
OR WHEAT 260,000,000 BU./YR.
OR MOLASSES 10,000,000 TONS/YR.
OR SUGAR BEETS, CANE OR POTATOES 32,000,000 TONS/YR.
6,400 MCF/DAY ETHANE
5,400 MCF/DAY ETHYLENE (OR ALCOHOL) 100,000 GAL./DAY
STYRENE 230,000 TONS/YR
STYRENE CHARGE STOCKS
GAS (NATURAL) 53,000 MCF/DAY
OR COAL 43,000 TONS/DAY
WHEAT 13,000,000 BU./YR.
BENZENE 140,000 GAL./DAY

Supply of Hydrocarbons Fully Adequate for Emergency Needs

By G. G. OBERFELL* and R. C. ALDEN†

WITH the advent of active participation by the United States in the war the C_4 hydrocarbons are of paramount interest and value as raw materials in the manufacture of synthetic rubber and aviation-fuel blend agents. Comparatively simple means are at hand for the conversion of these raw materials from one C_4 form to another C_4 form. For these reasons the following factors are generally more favorable when C_4 hydrocarbons are used as raw materials for the manufacture of aviation-fuel agents and synthetic rubber than is the case where one starts with crude oil or gas oil as a charge stock: (*a*) Less raw material handled; (*b*) higher yield of finished product; (*c*) lower investment costs; (*d*) less amount of critical materials and equipment required for plant construction, and (*e*) lower operating costs.

Only a detailed survey would make possible an accurate appraisal of the supply of these materials. This is especially true as to current and future production of C_4 hydrocarbons. In the absence of such a survey the accompanying estimate of past supplies is of interest. The assumptions made in arriving at the quantities here set forth are shown at proper places throughout the attached tables.

Most previous estimates on the supply of C_4 hydrocarbons have dealt with only the total amount of these hydrocarbons. The present estimate is an attempt to appraise the supply of the individual hydrocarbons, namely isobutane, isobutylene, normal butylene and normal butane.

There are three large sources of the C_4 paraffin hydrocarbons: natural gas, crude oil and cracking of naphtha or oil. The olefin hydrocarbons originate chiefly from cracking of oil or naphtha.

No attempt has been made to estimate current or future supplies and demands for C_4 hydrocarbons, since at nearly all refineries changes in operations are being made. Where aviation fuel is being manufactured these changes are in many instances in the direction of increasing the relative production of C_4 hydrocarbons. New aviation-fuel facilities are being installed. For example, some variants of catalytic cracking for aviation-base stock manufacture produce considerable isobutane, while others produce C_4 olefins.

*Vice president in charge of research. †Director of research, Phillips Petroleum Co.

Chief Uses for C_4 Hydrocarbons

The chief uses of the C_4 hydrocarbons are (*a*) as a front and volatilizer for motor fuel; (*b*) in liquefied petroleum gases; (*c*) synthetic-rubber ingredients, and (*d*) aviation-gasoline blend agents.

The estimated quantities (thousands of barrels per day) of C_4 hydrocarbons going to motor-fuel and L.P.G. uses as shown in Tables 4 and 6 are summarized as follows:

Period—	Motor fuel	L.P.G.	Total
1938	94	6	100
1939	100	8	108
1940	100	11	111
1941	113	18	131

Except for economic reasons ("Propane a Substitute for Butane in Motor Fuel," The Oil and Gas Journal, March 26, 1942) there is no necessity for C_4 hydrocarbons to be in motor fuel. Consequently, subject to availability of facilities for aggregating them, large proportions of the C_4 hydrocarbons in motor fuel should be considered as available.

As an illustration of the C_4 requirement for synthetic-rubber ingredients the following tabulation shows the amount of normal butane or normal butylene required to make 500,000 tons

TABLE 1—ESTIMATED POTENTIAL SUPPLIES (IN THOUSANDS OF BARRELS PER DAY) OF C_4 HYDROCARBONS AT UNITED STATES REFINERIES AND NATURAL-GASOLINE PLANTS

Period	Item	Iso-butylene	Normal bu-tylenes	Iso-butane	Normal butane	Total
1938	In natural gas to gasoline plants	None	None	54	108	162
	In refineries*	15(0)	35(0)	40(15)	78(29)	168(44)
	Total	15	35	94	186	330
1939	In natural gas to gasoline plants	None	None	54	108	162
	In refineries*	16(0)	37(0)	43(16)	84(31)	180(47)
	Total	16	37	97	192	342
1940	In natural gas to gasoline plants	None	None	58	117	175
	In refineries*	16(0)	37(0)	42(16)	84(31)	179(47)
	Total	16	37	100	201	354
1941	In natural gas to gasoline plants	None	None	67	135	202
	In refineries*	18(0)	43(0)	47(17)	94(33)	202(50)
	Total	18	43	114	229	404

*Numbers in parentheses are quantities in a straightrun gasoline. The difference between the two numbers is from cracking and reforming operations.

TABLE 2—ESTIMATED "READILY AVAILABLE"* SUPPLIES (IN THOUSANDS OF BARRELS PER DAY) OF C_4 HYDROCARBONS AT UNITED STATES REFINERIES AND NATURAL-GASOLINE PLANTS

Period	Item	Iso-butylene	Normal bu-tylenes	Iso-butane	Normal butane	Total
1938	At natural-gasoline plants	None	None	13	38	51
	At refineries	10	25	29	57	121
	Total	10	25	42	95	172
1939	At natural-gasoline plants	None	None	13	38	51
	At refineries	12	27	30	61	130
	Total	12	27	43	99	181
1940	At natural-gasoline plants	None	None	14	41	55
	At refineries	11	27	30	61	129
	Total	11	27	44	102	184
1941	At natural-gasoline plants	None	None	17	47	64
	At refineries	13	30	34	68	145
	Total	13	30	51	115	209

*By "readily available" is meant: (*a*) In the case of natural-gasoline plants, multiplying the potential supply (Table 1) by 70 per cent for geographical location and size discount and by 50 per cent and 35 per cent for extraction of normal and isobutane respectively. The latter represents estimated average practice. (*b*) In the case of refineries, multiplying the potential supply (Table 1) by 80 per cent for geographical location and size discount and by 90 per cent for extraction of C_4 hydrocarbons. The latter represents estimated average practice.

TABLE 3—UNITED STATES AVERAGE DAILY PRODUCTION OF CRUDE OIL, GASOLINE AND MOTOR FUEL IN THOUSANDS OF BARRELS PER DAY*

	1938	1939	1940	1941
Crude-oil production	3,300	3,460	3,700	3,850
Crude-oil runs to stills	3,190	3,390	3,540	3,860
Refinery straightrun gasoline	673	717	719	765
Refinery cracked gasoline	747	813	801	945
Refinery motor fuel	1,420	1,530	1,520	1,710
Natural gasoline	141	142	152	176
Total motor-fuel production	1,561	1,672	1,672	1,886

*U. S. Bureau of Mines statistics.

TABLE 4—ESTIMATED AVERAGE DAILY QUANTITIES IN THE UNITED STATES OF POTENTIALLY AVAILABLE C_4 HYDROCARBONS IN MOTOR FUEL†† AND VARIOUS STREAMS OF GASOLINE‡‡ IN THOUSANDS OF BARRELS PER DAY

	1938	1939	1940	1941
C_4's in motor fuel*	94	100	100	113
Butanes in natural gasoline†	28	29	30	35
C_4's in refinery motor fuel**	66	71	70	78
C_4's in refinery operations‡	168	180	179	202
Butanes in refinery straightrun gasoline§	44	47	47	50
C_4's resulting from cracking operations¶ **	124	133	132	152

*Average marketed motor fuel contains 6 per cent of C_4 hydrocarbons. See "Total Motor-Fuel Production," Table 3. †See Table 5. ‡Based on surveys, sufficient C_4 hydrocarbons are produced in normal refinery operations to make a refinery motor fuel containing 11 per cent C_4's. Therefore refinery straightrun gasoline plus refinery cracked gasoline (Table 3) minus C_4's in refinery motor fuel (Table 4) divided by 0.89 multiplied by 0.11 equals C_4's in refinery operations. §Butanes estimated as 6.5 per cent of refinery straightrun gasoline (Table 3). Estimated composition is: Isobutane, ⅛; *n*-butane, ⅞. ¶Estimated composition is: Isobutylene, 12 per cent; *n*-butylenes, 28 per cent; isobutane, 20 per cent; *n*-butane, 40 per cent. **By difference. ††The word motor fuel is used to designate the finished product. ‡‡The word gasoline is used to indicate a component used in motor fuel.

TABLE 5—ESTIMATED UNITED STATES DAILY AVERAGE QUANTITY OF BUTANES IN NATURAL GAS* AND NATURAL GASOLINE IN THOUSANDS OF BARRELS PER DAY

	1938	1939	1940	1941
Butanes in natural gasoline†	28	29	30	35
Butanes in natural gas to gasoline plants‡	162	162	175	202
Butanes extracted from natural gas§	73	73	79	91
Butanes in residue gas from natural gasoline plants	89	89	96	111

*Does not include natural gas not processed in natural-gasoline plants. †Average natural-gasoline production (Table 3) is 20 lb. R.v.p. containing 80 per cent pentanes and heavier. ‡Based on analyses of many samples of natural gas there is 1.43 gal. of butanes for every gallon of butane-free natural gasoline. Isobutane is one-third of total C_4's, the remainder is normal butane. §Assuming over-all average C_4 extraction of 45 per cent. Normal butane extraction is 50 per cent, isobutane extraction is 35 per cent.

TABLE 6—ESTIMATED AVERAGE OF BUTANES IN MARKETED LIQUEFIED PETROLEUM GASES IN THOUSANDS OF BARRELS PER DAY

	1938	1939	1940	1941
Butane	3.44	4.65	5.04	7.31
Butane and butane-propane mixtures*	2.74	3.38	6.05	10.70
Total	6.18	8.03	11.09	18.01

*Mixtures estimated as containing 75 per cent butane.

of butadiene per year at several conversion efficiencies for butylene-butadiene conversion but assuming a constant yield of butane to butylene of 80 per cent by weight.

Yield of normal butylene to butadiene (% by wt.)	Normal butane (bbl./day)	Normal butylene (bbl./day)
50	33,200	25,800
60	27,600	21,500
70	23,700	18,500
80	20,700	16,200

Statistical Analysis

Table 1 shows the estimated quantities of C_4 hydrocarbons "potentially available" at refineries and natural-gasoline plants for the years 1938, 1939, 1940 and 1941. It is noted that the total "potential" volume of all C_4 hydrocarbons increased from 330,000 to 404,000 bbl. per day.

Table 2 shows the estimated quantities of C_4 hydrocarbons that are "readily available," (as defined in the table) for the same years as shown in Table 1. It is to be noted that the "readily available" quantities of C_4 hydrocarbons increased from 172,000 to 209,000 bbl. per day.

The 1941 percentage distribution of the several C_4 hydrocarbons as shown in Tables 1 and 2 is as follows:

	Potential supply (per cent)	Readily available supply (per cent)
Isobutylene	4.5	6.2
Butylene	10.6	14.4
Isobutane	28.2	24.4
Normal butane	56.7	55.0
Total C_4 supply	100.0	100.0

It is interesting to note in Table 1 that the C_4 hydrocarbons in natural gas to gasoline plants is over 160,000 bbl. per day. This is very significant since this quantity of hydrocarbons is in many instances independent of the crude-oil production and therefore will not be affected to any great extent by changes or curtailment in the crude-oil supply and demand. Furthermore, the demand for natural gas is increasing as contrasted to a static or diminishing demand for crude oil.

Tables 3, 4, 5 and 6 present the basic statistical data and assumptions used in arriving at the estimates shown in Tables 1 and 2 and elsewhere. These tables are self-explanatory.

Conclusions

The available butanes and butenes in the United States have been estimated on the basis of past statistics and generalities of past operations. Without a doubt this does not represent actual conditions now prevailing. Nevertheless certain qualitative conclusions can be reached.

1. Normal butane is abundantly available.
2. The supply of isobutane and of C_4 olefins is proportionately small.
3. The potentially available supply of C_4 hydrocarbons from natural gas to gasoline plants is in many instances more or less independent of supply of and demand for crude oil.
4. There is a very large supply of C_4 hydrocarbons at refineries and natural-gasoline plants.
5. Normal butane constitutes between 55 and 60 per cent of the total immediate supply of C_4 hydrocarbons. Normal butane has been in only slight demand. The other C_4 hydrocarbons (iso-

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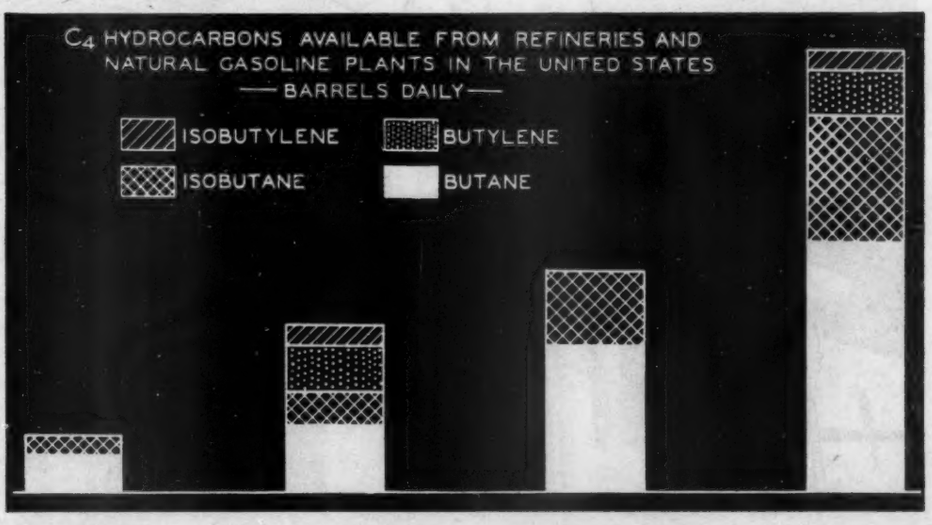


	At refineries — Skimming	At refineries — Cracking	At gasoline plants	Total
Isobutylene	.....	18,000	.....	18,000
Normal butylene	.....	43,000	.....	43,000
Isobutane	17,000	30,000	67,000	114,000
Normal butane	33,000	61,000	135,000	229,000
Total	50,000	152,000	202,000	404,000

Used Equipment Speeds Sun Butadiene Plant Construction

By J. P. O'DONNELL

THE first plant employing the Houdry process for the production of butadiene by catalytic dehydrogenation is scheduled to go into operation in March 1943. It is now under construction at the Toledo, Ohio, refinery of Sun Oil Co. The plant will have a capacity of 15,000 tons per year.

Sun Oil Co. is building the plant for Defense Plant Corp., will operate it and supply the butadiene to Rubber Reserve Corp.

Foundation work on the new unit was begun October 12, 1942. Therefore, if it is completed according to schedule, the construction time will be from 5 to 6 months. This time will compare with construction periods ranging from 6 to 13 months for other butadiene units, as reported by Albert I. Elder, WPB, in a paper delivered before the American Chemical Society in Buffalo last September.

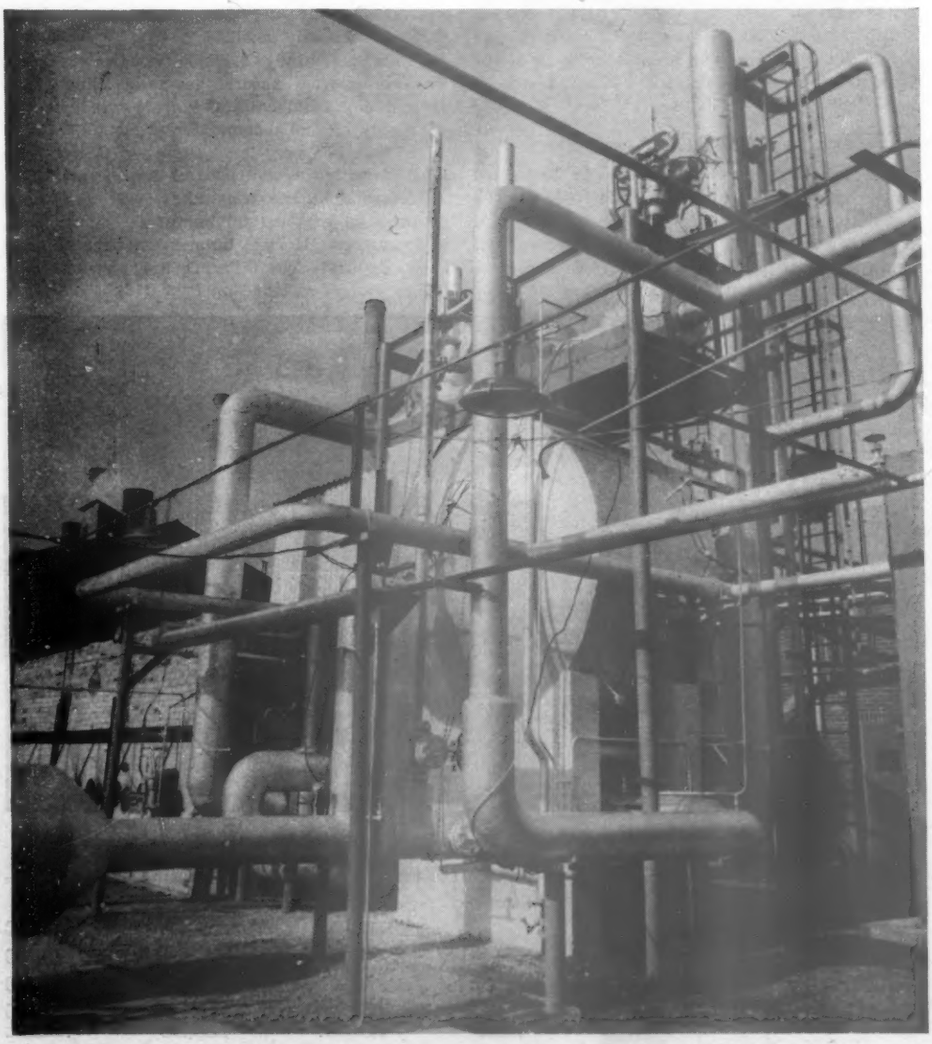
The speed of construction expected for Sun Oil Co.'s plant is important in view of the critical, immediate need for the development of a domestic supply of synthetic rubber. This speed was made possible by the fact that a plant employing the Houdry process may be constructed largely from second-hand equipment and by the fact that Sun's able material scouts located the necessary used material in an amazingly short time during an intensive search that was almost nation wide in scope.

Because of the immediate need for synthetic rubber, the speed of constructing units for the production of its major intermediate is a consideration of outstanding importance in evaluating available processes. Speed and actual cost of construction may depend to a very considerable extent on the relation between the amount of already available or second-hand equipment that can be purchased and used, and the amount of critical material requiring priorities, delivery of which may be delayed. Study of the detailed design of the Houdry unit revealed the fact that of a total estimated gross expenditure for this project of $3,254,420, actual value of material required in its construction amounts to only $1,720,000 Only $313,686 worth of new, critical material requiring priorities will be needed.

Total weight of the material involved in the construction of the plant, excluding masonry and lumber, is estimated at 6,025 tons. This total includes, principally, 3,132 tons of steel, 129 tons of cast-iron valves and castings, 108 tons of alloy steel, brass, bronze, and copper, about 500 tons of machinery, and 400 tons of insulation. Of the 6,025 tons required, only 1,200 tons, approximately 20 per cent, require priorities.

Coincident with the Defense Plant Corp.'s issuance of approval for the proposed plant, Sun Oil Co. made application for the necessary priorities. These were received September 18. Upon clearance of this final barrier, the company's engineering department instructed its material scouts to search every likely industrial area for second-hand equipment that could be used as such or converted for use in the plant.

Valuable leads to some of the material were furnished by the chief of the construction section of the Office of Petroleum Coordinator and by Defense Plant Corp.



Reactor in the Sun butadiene semicommercial unit

Nation-Wide Search

The search covered an area extending from East Coast docks and warehouses to Arizona and from Michigan to Texas. In the remarkably short time of 4 weeks, not only was all the second-hand equipment that it was possible to use located and purchased, but practically all of it is by now on the way to the site of the new plant. Orders for the majority of material covered by priorities also were placed during this time. Delivery of this material is expected to be an important factor in determining the date of completion.

The successful search for second-hand equipment was the most spectacular achievement in the short history of the plant. The greatest single windfall was a large order for refining equipment that had been stored at East Coast docks and warehouses in anticipation of overseas shipment. This shipment had been assembled just before the war and had been held up when hostilities began. Sun purchased most of the lot and it is now being converted into fractionators, heat exchangers, gas coolers, accumulators, etc., for use in the new butadiene plant.

Other and equally unusual sources of second-hand material were a copper mine in Arizona which furnished a blower; an ice-cream factory in Philadelphia and ice-plant installations in New York and Chicago which provided compressors, motors, condensers and accessories for the refrigeration unit of the butadiene plant; and a chemical plant in Tennessee where boilers, including stacks, fans, pumps, and accessories were located. Another suitable blower was located in Boston and absorbers were purchased in Oklahoma. Water-softening equipment for the boiler house was found in the stock of a water-treating-equipment manufacturer. Five large pumps and motors were located in the salvage department of

a chemical concern in Delaware and will be used in the water-circulating system.

Sun's own widespread operations yielded a substantial portion of the material. Its refineries at Marcus Hook, Pa., Toledo, Ohio, and Yale, Okla., furnished towers, vessels, and second-hand plate for strippers, scrubbers, absorbers, and old shell stills, and pressure vessels that are being adapted for use in the new plant as surge tanks, accumulators, storage tanks, suction traps for butane and butadiene, oil separators, etc. One of the refineries is also supplying a complete heater which will be equipped with used heat-resistant alloy tubes and return bends. Another refinery will contribute a large, spheroid tank for the storage of butane. This storage is equipped with an auto-refrigeration system.

Sun's producing properties also contributed to the supply of equipment for the new plant. Producing department warehouses in Michigan, Oklahoma, and Texas gave up second-hand gas compressors, miscellaneous pipe and fittings, and electrical equipment which is now being reconditioned. Some of the second-hand material available from these sources will be combined with new material, to construct certain sections of the plant. The six reactors, for example, are being built from second-hand steel plate with only the insulation and lining being new. Both new and second-hand equipment, which, fortunately, was on hand before the priorities system went into effect, will go into the construction of a large cooling tower equipped with condensing and cooling sections.

Since the Sun plant will have a capacity of 15,000 tons per year and the estimated gross expenditure involved for a plant built entirely from new material is $3,254,420, the cost is equivalent to $217 per ton of annual capacity. The low cost of the Sun plant is attributed to the fact that the Houdry process is relatively simple in design and can employ much used equipment and to the successful search for such equipment by the company's material scouts.

Other favorable characteristics attributed to the Houdry process are the ready availability of noncritical material as charging stock and the high yield of butadiene from the charging stock, normal butane. An estimated 175,000 bbl. per day of butane are available from natural gas at gasoline plants, cracking processes at oil refineries, and from crude oil run. Butane is not only available in large quantities but it is a noncritical material inasmuch as its use would impair the production of other war-essential products, such as 100-octane aviation gasoline. The yield of butadiene from butane by the Houdry two-stage catalytic dehydrogenation process, as indicated in both pilot and semicommercial plant operation, is approximately 67 per cent. Thus, if 50,000 bbl. of butane, or less than one-third of the butane estimated to be available, were processed daily in plants of this type, they would have an annual production of well over 1,000,000 tons of butadiene per year, sufficient for about 1,300,000 short tons of buna-S type synthetic rubber.

The first description of the process and a simplified flow chart were published in August 20 issue of The Oil and Gas Journal, Pages 30-31. This description stated that initial yields, on a weight basis, were: butadiene, 67.07 per cent; fuel gas, including hydrogen, 21.99 per cent; and catalyst deposits, 10.94 per cent. Further studies, based on semicommercial-plant operation, have confirmed results obtained in earlier laboratory and pilot-plant operations.

Steps in Process

Simply, the process consists of two successive dehydrogenation steps. Products of the first stage are butylene, butane, and lighter gas. The butane and butylene are concentrated in a vapor-recovery system and charged to the second stage wherein the butadiene is produced. The heat-retaining capacity of the reactors permits the use of the heat produced during the burning cycle of

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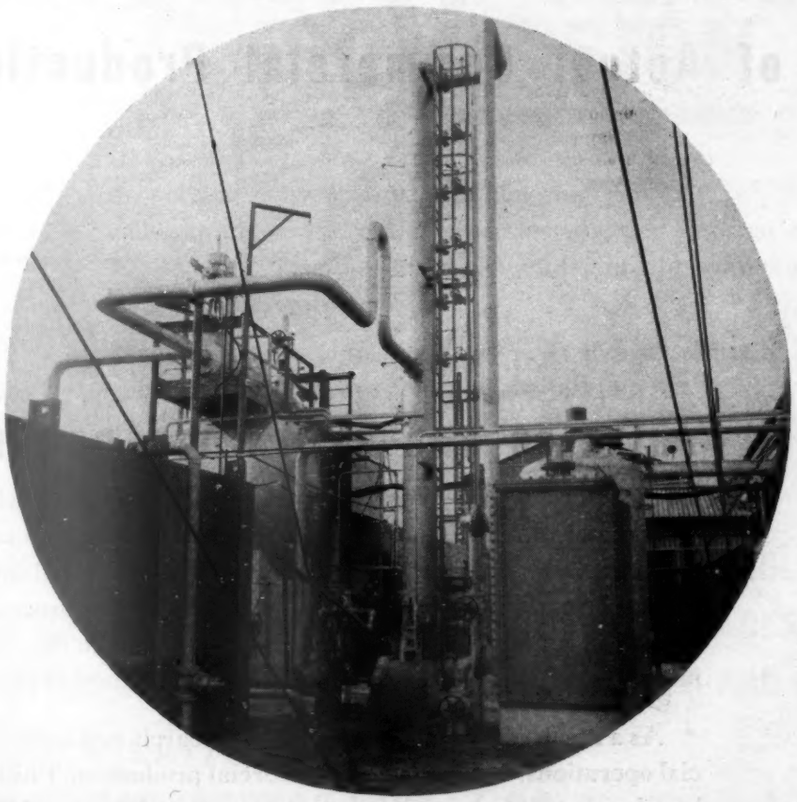
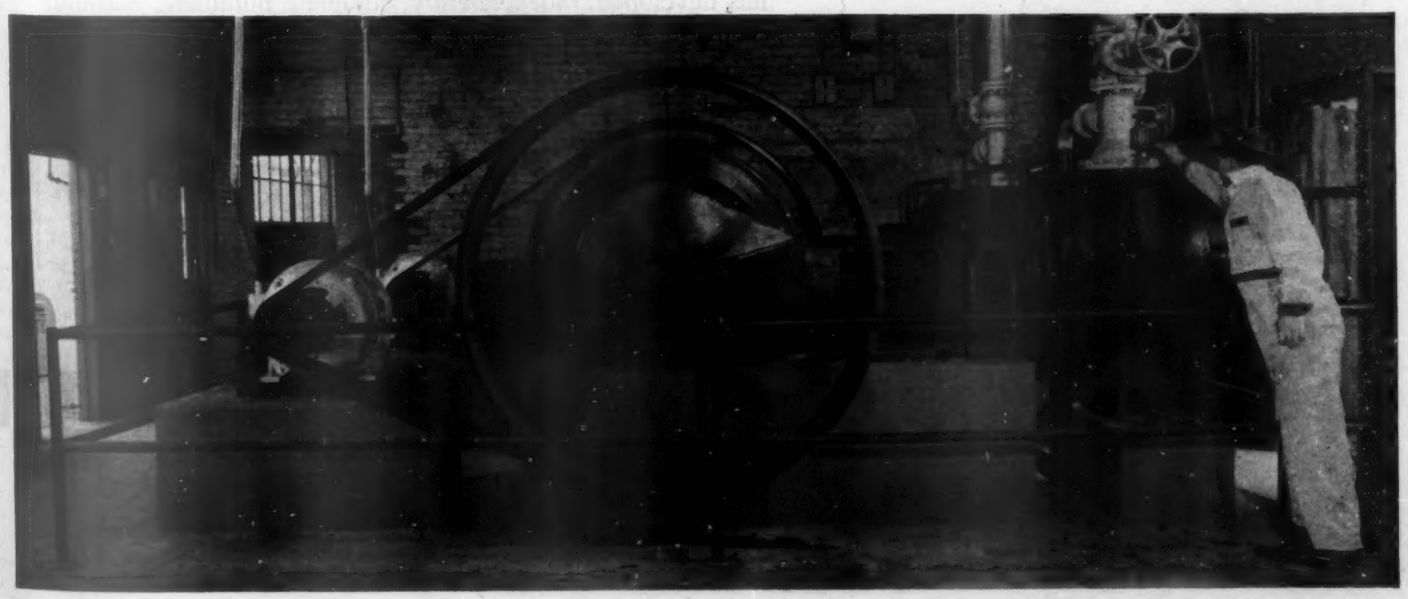
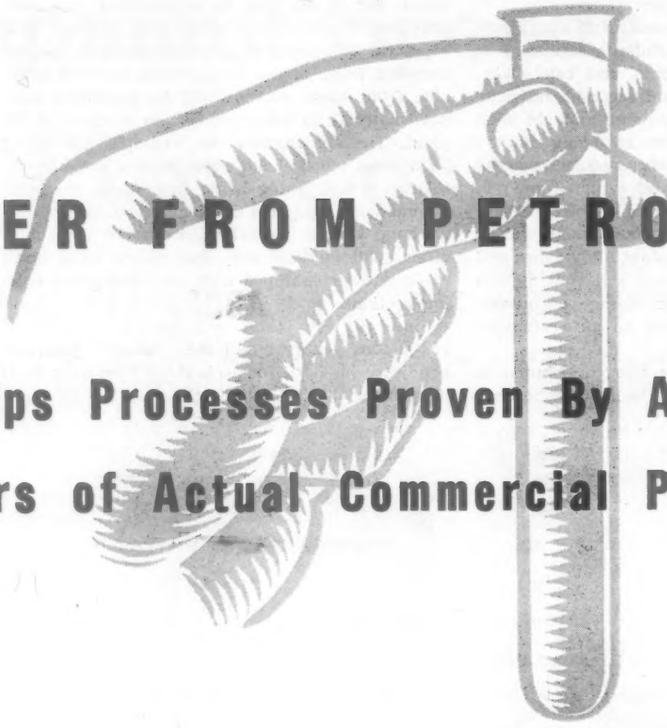




Left: Quenching unit in the Sun semicommercial butadiene plant. Below: Two of the vacuum pumps maintaining the required subatmospheric pressures in the Sun plant



RUBBER FROM PETROLEUM

Phillips Processes Proven By Almost Two Years of Actual Commercial Production

PHILLIPS AND SYNTHETIC RUBBER

Long before World War II made synthetic rubber such a vital material, more than a decade before, Phillips research chemists were studying various processes that isolated butadiene. As early as 1932 patents were applied for on processes that, with refinements, are now important stages in the commercial production of the raw materials for synthetic rubber.

As a result of continued laboratory research, test commercial operations, and full scale commercial production, Phillips has developed, independently, complete butadiene manufacturing and purification processes which are available to other refiners or natural gasoline manufacturers interested in butadiene production. Of extreme interest is the fact that Phillips processes have actually demonstrated, by almost two years of successful operation, that they will produce high quality butadiene effectively and economically.

PHILLIPS PETROLEUM

AND NOW FROM PHILLIPS RESEARCH LABORATORY COMES ANOTHER REVOLUTIONARY NEW PROCESS TO SPEED THE VICTORY DRIVE

ISOVERSION

Isoversion converts hydrocarbon material now of almost no value to the war effort, into products needed in large quantities for aviation gasoline, for the manufacture of synthetic rubber and for other war materials.

Isoversion gives almost perfect yields and substantially increases the potential supply of a vital war material.

Isoversion will be available to all refiners and natural gasoline manufacturers.

OTHER PHILLIPS PROCESSES ARE ALSO AVAILABLE TO REFINERS AND NATURAL GASOLINE MANUFACTURERS WHO DESIRE TO STEP UP WARTIME PRODUCTION OF SYNTHETIC RUBBER AND AVIATION FUELS.

ALKYLATION
GAS DEHYDROGENATION
CATALYTIC ISOMERIZATION
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COMPANY *Bartlesville, Okla.*

STYRENE BUTADIENE

AVIATION GASOLINE

They're all the same to

The more than 100 ISO-FLOW* Furnaces put into operation and under construction so far this year for the manufacture of Styrene, Butadiene, Aviation Gasoline, Toluene, Lube Oils, required 30-50% less critical materials than for conventional box type furnaces.

*Trade Mark. Patents issued and pending.

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Styrene for Rubber Made From Benzene, Alcohol or Ethylene

BECAUSE of its use for some years in the preparation of polystyrene resins and the consequent knowledge chemical manufacturers have obtained of its manufacture, the synthesis of styrene has not offered the problems that has been the experience with butadiene. The principles in making styrene and its troublesome peculiarities are well known.

Styrene is synthesized by the Friedel-Crafts reaction, using ethyl halides such as chloride and benzene, derived from either coal tar or petroleum. In an earlier Dow Chemical process benzene and ethyl chloride were reacted in the presence of aluminum-chloride catalyst to form ethylbenzene. This side chain was chlorinated to form alpha and beta chlorethylbenzenes which were separated and the beta compound was hydrolyzed to form betaphenylethylbenzene. This alcohol was dehydrated by employing an alkali such as caustic soda or potash, lime, etc., to give styrene, or phenylethylene. This process had the grave disadvantage, in emergency production of huge quantities, of requiring large amounts of chlorine.

Styrene by Alkylation

Styrene may be produced direct by the carefully controlled interaction of acetylene, from calcium carbide or by checking ethane-propane gases with benzene under reduced pressures at 800°-1,000° C. A poor yield of styrene is also produced by heating acetylene at 600° C., without the introduction of benzene, but the process has not proved commercially practical. It may be prepared in an expensive way by hydrogenating and then dehydrating acetophenone, using a mixed copper oxidechromic-oxide catalyst.

The most common processes, however, use alkylation of benzene with ethylene or alcohol catalytically, to produce ethylbenzene. In the Dow process as now carried out on a large scale, hydrocarbon gases such as ethane are cracked to form ethylene, $H_2C = CH_2$. Ethylene, essentially free from propylene which would form propylbenzenes in the reaction, is brought into contact with benzene in the presence of anhydrous aluminum-chloride catalyst. At temperatures of about 190° F. and gage pressure of 15 lb., using a nitration-grade benzene (boiling range, 1° F.), high yields of ethylbenzene are obtained, it is claimed. Only minor lowering of the yield results from the use of benzene of 2° F. boiling range, and the ethylene may be used in concentrations with other gases as low as 38 per cent. Yields of 75 to 100 lb. of ethylbenzene are obtained per pound of catalyst, which may be made from low-grade scrap aluminum or from bauxite. Up to 80 per cent of the catalyst can be recovered, it is said, and the polyethylbenzenes formed as byproducts during the reaction may be dealkylated to form the mono variety. Sulfur has no adverse effect on the reaction it seems, since hydrogen sulfide is formed by the action of the catalyst and this sulfide is eliminated from the system.

In another process, benzene is alkylated with ethyl alcohol of 95 per cent purity. The alcohol and benzene are brought into contact with an inert solid catalyst saturated with phosphoric acid, at about 600° F. and pressures of the order of 250-lb. gage. This general type of reaction is that employed by Koppers Co. in its Beaver Valley unit, although the catalyst in this plant is not disclosed, for obvious reasons. This operation requires the removal of a molecule of water for each molecule of ethylbenzene produced. Either this water must be fixed, that is, must be removed from the reaction system or its presence has adverse effects, a provision which it is understood has been overcome in commercial practice. One method for attaining this result is to carry the junction reaction through on only a relatively small percentage of the reactants, remove the water and other undesired byproducts, segregate the unreacted components from other products and recycle these components. This procedure is similar to that employed in thermal cracking of hydrocarbon oils, which results in a greatly improved over-all conversion of the charge to the desired products and a minimum yield of useless byproducts.

The step which forms ethylbenzene is, however, the simpler of the two main steps required to produce styrene. Ethylbenzene must be dehydrogenated to styrene. Dehydrogenation may occur either in the side chain—ethyl group—or may occur in the benzene ring with the formation of numerous byproducts, none of which are desirable. Much of the research work which has been carried out on styrene production has been for the perfection of this dehydrogenation reaction. One problem has been that pyrolytic cracking produces a long series of materials other than that desired.

By preheating the ethylbenzene vapors with an excess of highly superheated steam, the "cushioning" effect of the steam and it dilution tendency removes two hydrogen atoms from the side chain without forming tars, carbon and highly complex molecules which reduce the yields.

Styrene polymerizes readily to a clear, solid resin. In purifying the monomer by distillation, operators on one occasion were surprised to find that solid styrene practically filled it. It was found that small percentages of sulfur effectually inhibited the polymerization without offering serious difficulties otherwise.

Again, a bromide-bromate test of the styrene content on the rundown product showed practically 100 per cent styrene. Later information indicated well over 100 per cent product. It was found that phenylacetylene was present in small proportion as an impurity. Acetylenes are "poison" in rubber synthesis, and the purity of the intermediates is the important consideration.

Inhibitors Necessary

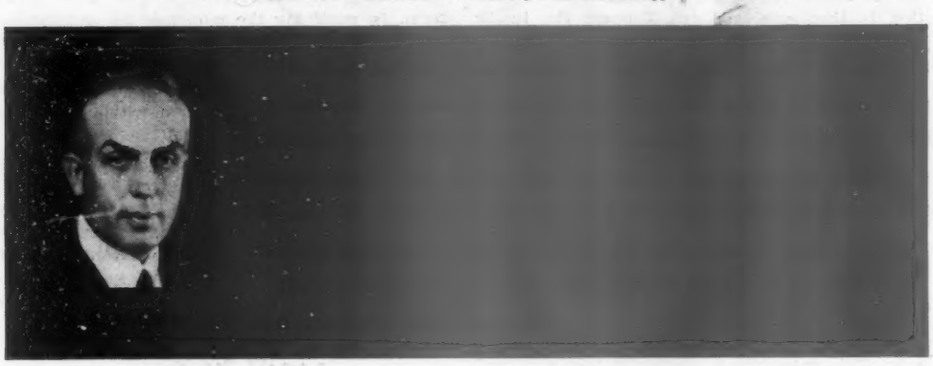
Introduction of inhibitors became necessary to avoid decomposition and discoloration of the product. Substituted catechols were found to prevent this development. Therefore, such materials as teritary butyl-catechol in very small quantities of not more than 0.005 per cent are added to avoid incipient decomposition.

Other methods for preparation of styrene are known. The dehydrogenation of ethylbenzene with a mixture of aluminum oxide and vanadium oxide, chromic oxide, or with zinc chromate alone ($ZnCrO_4$), as catalyst have proved successful but have not been used commercially. Zinc chromate used at 600° C. or lower temperatures has the advantage that it does not promote removal of the side chain for the formation of more complex aromatic products. This catalyst may attain prominence in the future, when time is available for research to bring out its special advantages. However catalysis will doubtless control the field, whatever may be the specific catalyst eventually proven to be most efficient and economical.

Rubber Director W. M. Jeffers (right), P. W. Litchfield, chairman of Goodyear's board (left), and E. J. Thomas, Goodyear president (center), inspect synthetic-rubber output

Methods of Manufacturing Synthetic-Rubber Intermediates

By C. R. WAGNER
Consultant in Petroleum Chemistry and Technology



THE principal raw materials involved in the present synthetic-rubber program are butadiene, isobutylene, styrene, isoprene, acrylonitrile, and perhaps such extenders as the methacrylate resins and similar materials. As can readily be seen, most of these products can be, or will be, manufactured from petroleum, although other industries may also contribute substantial quantities. The compound needed in largest amount, and the one requiring the heaviest outlay of money and strategic materials is, of course, butadiene.

Butadiene may be produced from almost any organic substance by high-temperature treatment in the presence or absence of catalysts. For obvious reasons, however, the commercial production of butadiene is to be limited to a small number of processes using a few source materials. Time only can tell whether the best processes and the most suitable starting materials have been chosen. Had the war been delayed another year or two, our knowledge of the methods for making butadiene would have been much more extensive and we should have been proportionately nearer to the best way of producing nearly a million tons per year of rubber. In an article of this sort it is not possible to discuss in detail all of the possible methods for making butadiene, and in most of the processes mentioned many of the important details must be omitted from discussions until after the present emergency.

For many years it has been known that butadiene existed, along with other diolefins, as an undesirable constituent of cracked distillate and gases from vapor-phase cracking operations. According to data published in the late twenties, about 1 per cent of the fresh gas oil charged to a low-pressure vapor-phase cracking unit operating at about 1,100° F. outlet temperature appeared in the cracked products as butadiene. A B B* cut from such a cracked distillate contained 10-15 per cent butadiene. As pressures were increased the production of dienes decreased, and above 150-200 lb. per sq. in. the quantity of diolefins in the cracked products was negligible. If pressures were kept low, however, and temperatures increased, then production of dienes increased gradually, passed through a maximum, and then rapidly fell off as the hydrogen content of the products rose.

If optimum temperatures for butadiene production in tubular units (1,250°-1,400° F.) are used, considerable quantities of aromatics are formed simultaneously. It will be recalled that Dunstan and his associates of Anglo-Iranian Oil Co. proposed many years ago a theory according to which benzene was formed from butadiene and ethylene, which first produced cyclohexene and then, by dehydrogenation, benzene. In view of the present and prospective shortage of aromatic hydrocarbons, we would be fortunate now to have a number of plants producing butadiene by high-temperature treatment of naphtha and/or gas oil. The losses to dry gas are very high, and the process is therefore a wasteful one, but it has the advantage that it can be placed in operation rather quickly by using existing equipment with relatively minor changes. The over-all requirement for critical materials in a wholly new plant is not out of line with the requirements of a catalytic process, starting with *n*-butane, and the installation cost per ton of butadiene is comparable. The obvious advantage of such a process lies in the fact that the technique for building and operating the plant is not new, and nearly every refinery has a crew of men capable of running such a plant.

*B-B cut = butanes-butenes fraction.—Ed.

PIWC-OPC Conversion Program

The Petroleum Industry War Council and the Office of Petroleum Coordinator have sponsored a refinery conversion program based, at least partially, on this process. Existing equipment will be used to raise the oil vapors to a temperature above 1,000° F. and then these hot vapors will be very quickly heated in checkerwork chambers to the desired cracking temperature of 1,300°-1,400° F. This additional heat may be supplied by the checkerbrick (using regenerative stoves), by superheated steam, by neutral combustion gases, or by introducing air to induce partial combustion of the oil vapors themselves. By keeping the time of contact very low (which means high velocities and correspondingly high-pressure drops across the chambers) even higher temperatures may be used to obtain better yields of butadiene than can be secured at 1,300°-1,400° F. in either tubular units or checkwork chambers. The disadvantages involved in such a process are: insufficient data on which to base design of the equipment, shortages of suitable

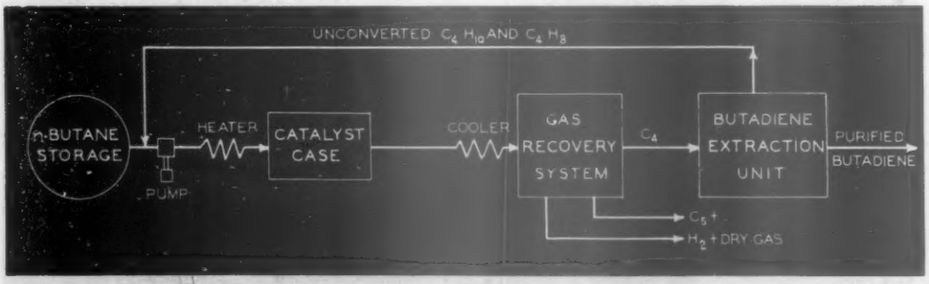


Fig. 1—(Left) One-step butadiene process

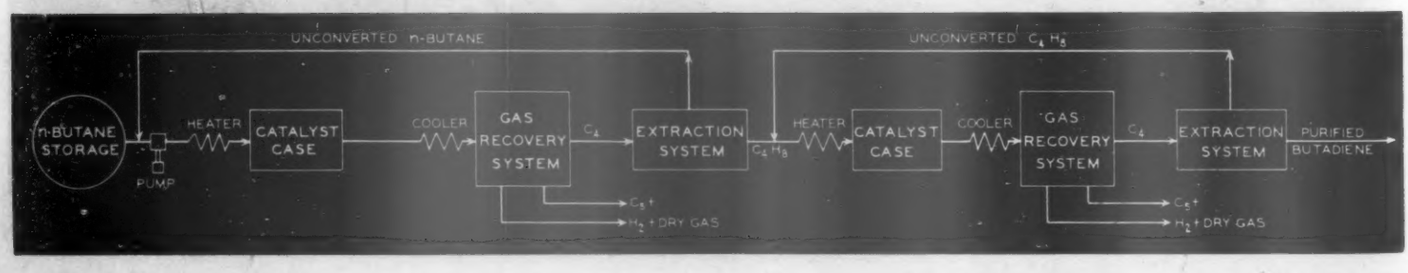
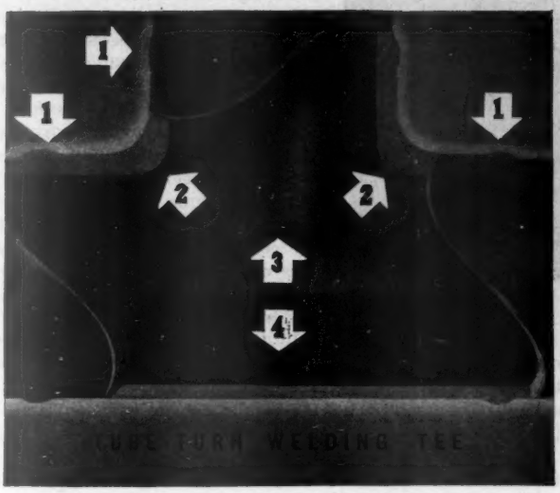
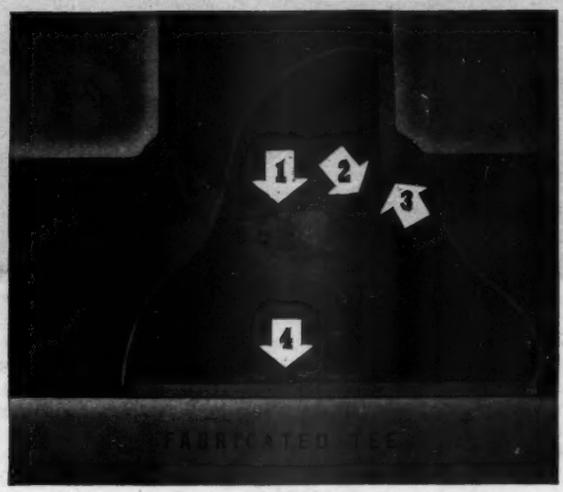


Fig. 2—(Below) Two-step butadiene process

Why TUBE-TURN WELDING TEES provide strong, safe, easy-to-weld branch connections



(1) Easy circumferential butt welds cut installation time, make sounder, safer joints. (2) Easy sweeping curves reduce friction and pressure loss to a minimum. (3) Smooth inside walls assure even flow and add to the long life of the connection. (4) No accumulation of slag.



(1) Joining a branch into a main with an intersection weld makes a weaker, less sound connection. (2) Gaps and irregularities caused by uneven cutting must be filled by welder. (3) Sharp corners and jagged angles are poor piping practices. (4) Possible slag accumulation can impede flow and seriously injure valves.

COMPARE the two cut-away illustrations above point by point for *proof* of the unmistakable superiority of welding tees.

It takes *fewer man-hours and far less trouble* to install a Tube-Turn welding tee into a piping system than to fabricate a branch connection, a vital factor in today's plant expansion and modernization for war needs. Other major advantages of these seamless welding tees are the *greater strength, longer life,* and *smooth flow* secured.

The design and construction of Tube-Turn welding tees *add to the strength of the entire piping system* by reinforcing these crucial points.

8 REASONS FOR SPECIFYING TUBE-TURN WELDING TEES

1 *Extra thickness at crotch* reinforces where highest stress occurs.

2 *Reinforcement along top of run* adds needed strength here.

3 *Reinforcement on side*—also a point of high stress gradually tapers toward end of outlet and bottom of run.

4 *Longer outlet* permits faster lining up and ample room for rod manipulation.

5 *Ends machined* to exact pipe wall thickness—easy to align and weld.

6 *Increased bottom thickness* at adds to full strength without excess weight.

7 *Smooth inside walls, curved inner crotch and special manufacturing process* assure even flow.

8 *Size, material, thickness and name* identified on permanent name-plate.

Tube Turns manufactures a complete line of welding fittings and forged steel flanges in all standard sizes and weights. Write for new complete catalog and valuable engineering data book No. 111. It's free.

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TUBE-TURN
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Welding Fittings

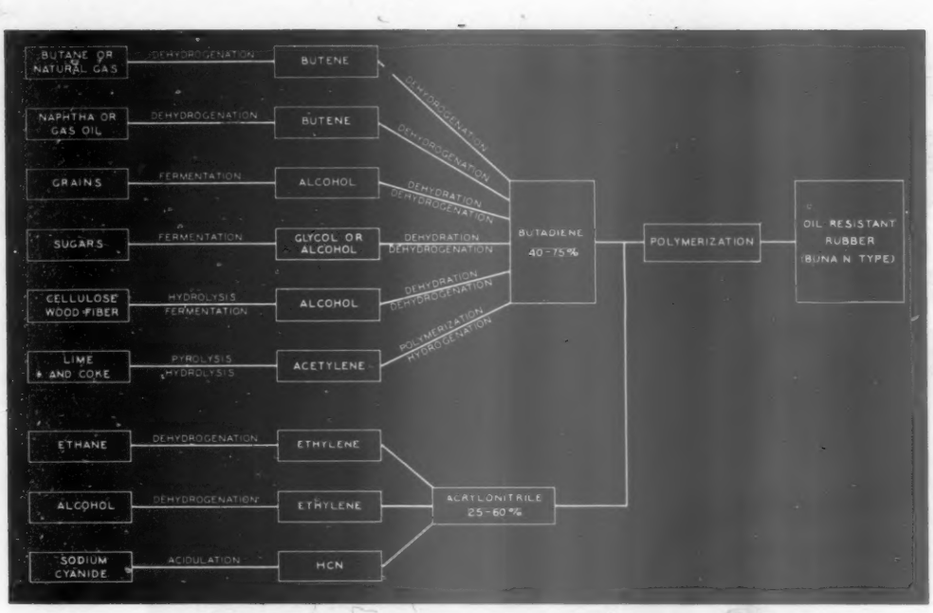


Chart showing preparation of oil-resistant rubber

material for checkerwork, difficulty of constructing quickly the equipment to secure the necessary high vapor velocity and freedom from channeling, and a lack of trained technical men to design and operate the units.

Among the catalytic processes for producing butadiene may be mentioned those starting with the following raw materials: *n*-butane, *n*-butylene, ethyl alcohol, ethylene and acetylene. Of these raw materials *n*-butane is much more abundant than any of the rest. The total supply in the United States cannot be regarded as all available, since a considerable quantity is produced in refineries or in natural-gasoline plants which do not have the equipment to extract it. In many of these plants the quantity available is too small to justify installing equipment to recover it. Various estimates of the total quantity produced in the country have been published during the last year, ranging from about 100,000 to nearly 200,000 bbl. per day.

Estimates of the quantity of *n*-butane required to produce a ton of butadiene per year have varied from 0.05 to 0.08 bbl. per day. If we assume that 800,000 tons of butadiene may be required per year, and that all of it were to be produced from *n*-butane, then the *n*-butane demand would be between 40,000 and 64,000 bbl. per day, or much less than half of the total production of *n*-butane. Even when we discount production by the amounts economically out of reach, there still remains an ample supply of *n*-butane for any presently anticipated need for butadiene.

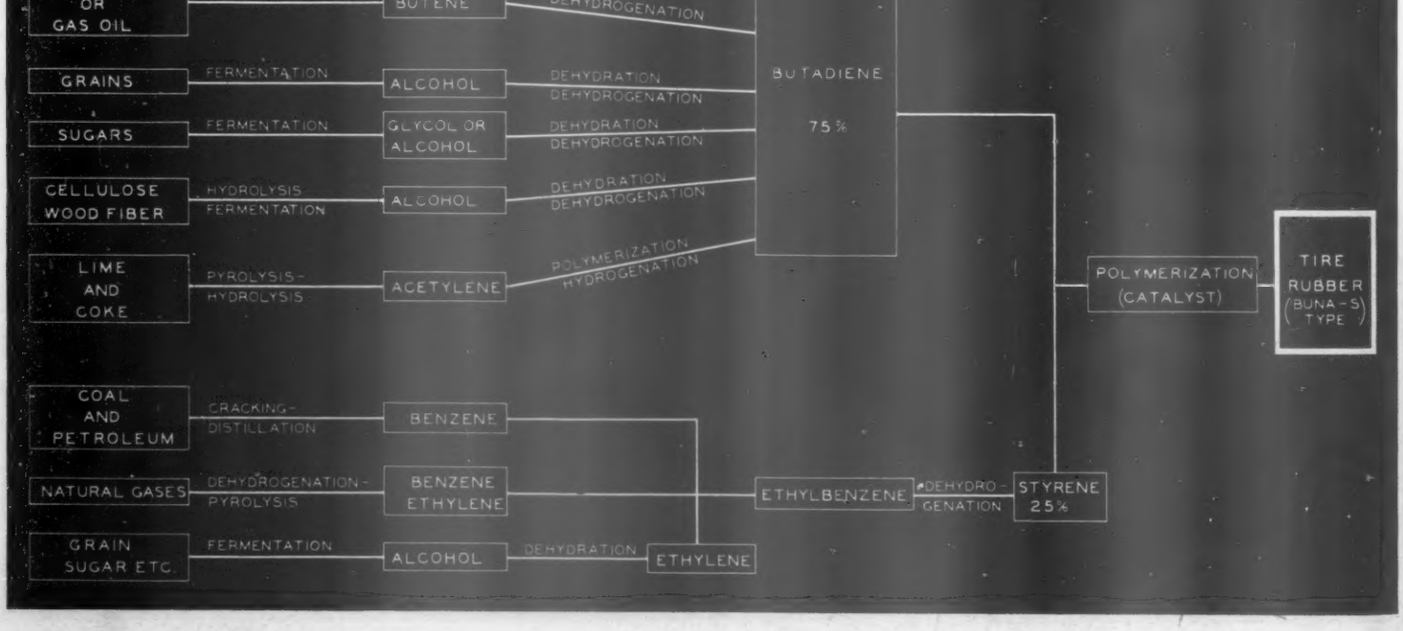
Processes for converting *n*-butane to butadiene are several in number. Although not economically sound for new plant construction, it is possible to crack *n*-butane noncatalytically, at high enough temperatures to secure a B-B cut containing notable quantities of butadiene. The process is also wasteful of *n*-butane, and the products contain an excessive quantity of ethylene and ethane. Where *n*-butane is being used as a source material, therefore, catalysts are used to promote breaking of the carbon-hydrogen bond and to suppress scission of the carbon-carbon bond.

These catalytic processes may be divided into two classes: (1) Single-step processes; and (2) two-step processes with intermediate separation of hydrogen. In the single step processes, temperatures are carried high enough to promote the dehydrogenation of butylene. (It is well known that olefins require higher temperatures for cracking or dehydrogenation than the corresponding paraffins.) This condition results in the conversion of considerable *n*-butane to products other than *n*-butylene, but simplification of the process is effected, as can be seen by comparing Figs. 1 and 2.

By the two-step process with intermediate separation of waste products, it is possible to convert *n*-butane at the temperature best suited to the simple dehydrogenation step, and much less of the unwanted byproducts are produced. The dehydrogenation of butylene to butadiene is much more difficult to carry out under optimum conditions, since temperatures are higher and pressures should be lower than in the treatment of the *n*-butane. If this low partial pressure is secured by use of an inert gas, such as methane, the gas-recovery system load is tremendously increased. If steam is used as the diluent, then a huge boiler plant is required as an auxiliary. The use of either diluent also causes a very much greater consumption of fuel and cooling water

(Continued on Page 113)

Chart showing preparation of tire-type rubber



Chemical Materials Used in Rubber Manufacture

THE mere blending together and polymerization of the major components of synthetic rubber by no means constitutes the entire process of synthesizing rubber to a useful, commercial compound. Nor do these two main ingredients constitute the whole of the materials going into the makeup of synthetic rubber. Rubber prepared from these major components requires the use of a number of chemicals and other materials which individually and collectively exert a profound influence on the properties of the finished rubber, just as is the case with natural rubber. During the last century an unbelievable amount of research work has been carried out on natural rubber, and the remarkable improvement in the tire of today, as compared with those made 25 years ago is the result of these inch-by-inch developments.

Relatively very few epoch-making discoveries have been made to bring rubber making to the point where it now is. Vulcanization, effect of fillers like carbon black, mastication—these were basic and fundamental discoveries the results of which changed the course of rubber research. But rubber as we have developed it is mainly the result of painstaking research and "cut and try" experimental effort, wherein positive results changed the properties of the product but little, albeit importantly. Much of rubber experiment must involve long-time test periods in service, where the effect of a single small change in processing the rubber may not be known for 2 or 3 years. Much of the experimental work has been very meticulous, the constant trying of small changes in concentration of additive materials, of proportions of rubber of different properties, of series of chemicals differing but slightly in composition and their effect on rubber qualities, of time periods and operating conditions and the effect of these differences on properties. The total number of individual experimental problems worked out by the rubber chemists in this country alone runs into the hundreds of thousands, as recorded in our rubber technical literature.

Chemicals employed in manufacture of synthetic rubber are similar in types to those used for natural rubber; in many cases the same products are used.

Synthetic rubber requires more softener effect than does natural rubber. Phthalates, sebacates, ricinoleates, and numerous proprietary materials are used for softening the synthetic crude product.

Sulfur and organic disulfides are employed for vulcanization. Organic amines are used as inhibitors against oxidation, or aging; the greater degree of saturation of synthetic rubber requires less inhibitor, and synthetic rubber resists oxidation better than natural rubber.

The properties of synthetic rubber may be varied over wide limits by the use of different types of carbon blacks. Fine-grained blacks like ink and acetylene blacks improve tensile strength most; for tread stocks fine-grained black is best; for side-wall rubber the finer thermal and reinforcing blacks give best results. Nitroparaffins, such as nitroethane, are used as heat sensitizers.

Improvements in rubber, therefore, are the composite result of the small and less-than-fundamental findings of these innumerable experiments. Save for those few really important discoveries which changed the face of rubber technology the mountain of rubber-making art and science may be likened to a structure composed of minute grains of stone, bound together by the cement made of the thinking and the work of thousands of rubber chemists over the last century.

Research Improved Rubber

Particularly after the discovery of vulcanization the attention of chemists began to be directed more and more to methods for varying the properties of the product. It was too stiff and hard; it was too soft and flexible; it aged too fast; it wore out too fast; it was too tough, too brittle, affected too much or too little by solvents, heat, cold, hysteresis set in too soon. Innumerable shortcomings existed in the product which made it undesirable for many applications. Yet its one or two inherent properties—flexibility, chemical inertness, imperviousness to liquids and gases—made it a promising prospect for adapting to a multitude of uses for which the new civilian had need, many of them urgent.

Because the fundamental chemistry of rubber is even yet so obscure and comparatively so little understood, much of the research work in earlier days, as is the case generally at present, followed the method of trial and error. Rubber chemists simply tried this material, that and another, to find something which would effect changes in properties which would make the product more serviceable for given purposes, improve certain properties which were useful but not up to as high standard in the raw product as was desirable. Gradually over the years, addition agents were found which increased the elongation or "stretch" of natural rubber; others which gave added tensile strength, or resistance to breaking or tearing apart when a piece of rubber was subjected to stress or shearing forces. Borrowing from chemical knowledge in other fields, making long excursions into new chemical territory by the laborious method of trying, one after the other, hundreds and thousands of different chemicals in varying quantities, different processing methods and manufacturing conditions, means was found for treating rubber to combat oxidation or the aging of rubber exposed to the air, water, and other damaging conditions in service. Any material which may be distorted in shape or size and which, when the distorting force is removed, will return to more or less its original

(Left): Chemical control of synthetic-rubber manufacture is all-important. Here are control-recording instruments such as are used to "keep a finger on the pulse" of this synthesis, to check and control quality and quantity of chemicals employed. (Right): Here a workman is adding the desired chemicals to a "batch" of intermediates which will be polymerized to form rubber

form and shape, eventually under repeated application of this stress or force gradually loses its power of resumption of original form. Its resilience or rebound is gradually lost. Methods have been developed to retard or postpone the time when this loss of resilience occurs, and the literature and technology of these developments make up one of the broadest pages in science.

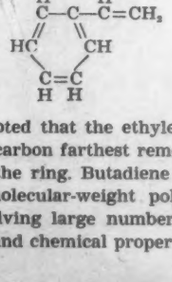
With the advent of synthetic rubber relatively few new problems were encountered, but the conditions of the various difficulties are changed in synthetic products. Generally speaking, the same types of plasticizers, softeners, accelerators, tackifiers, inhibitors and other chemical aids are useful in both natural and synthetic-rubber processing. In many cases it occurs that the individual chemical or family of chemicals which have proved best for natural rubber do not give the best results with the synthetic counterpart. In fact one of the greatest though not the most pressing problems of the synthetic-rubber industry is to determine the optimum types of compounds, their proportions, mixtures and methods of application of chemicals and filler materials for synthetic rubber. It is to the satisfactory solution of this army of problems that we may look for the improvement in synthetic-rubber quality which will inevitably follow in the course of a few years, a development which will parallel that achieved in the perfection of natural-rubber processing. To aid in this quest we have the invaluable background of the immense amount of information available on our discoveries in natural-rubber technology.

Chemicals Affect Properties

It is not the purpose or need in this article to cover exhaustively the fields of accessory chemicals and auxiliary materials used in rubber processing. After all, those fields are the workshop of the rubber chemist, not the petroleum technologist. We present here, therefore a brief resume of the important phases of the problem faced by the rubber chemist in his ceaseless and already rather successful effort to provide a synthetic product which will "out-Herod Herod" in the rubber industry.

In processing synthetic rubber, the need for controlling chemical treatment begins with the raw intermediates. Butadiene, because of its high state of unsaturation, is highly reactive, reacting with many other compounds and elements, or polymerizing with itself to form gummy, rubber-like masses which not only waste the material which should be available for rubber production but causing troublesome difficulties in processing equipment, in transportation and storage containers. Under certain and to-be-avoided conditions butadiene is moderately explosive, and care as well as chemical treatment must be used to prevent the materialization of these hazards.

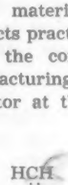
It has been found necessary to add to butadiene inhibitor types of chemicals to retard or prevent polymerization during transport or storage. Butadiene dimerizes, that is, two molecules polymerize to form a C_8H_{12} complex, a ring compound of cyclohexene with an ethylene side chain, which is termed ethylenecyclohexene or ethenylcyclohexene,



in which it is noted that the ethylene side chain is attached to a carbon farthest removed from the double bond in the ring. Butadiene also polymerizes into high-molecular-weight polyolefin chain compounds involving large numbers of C_4 units, whose physical and chemical properties vary with the molecular weight. This reaction has been used to produce materials such as Buna 85 and 115 (molecular weights about 85,000 and 115,000, respectively) which appear to belong to and to be useful in the plastics field as well as for possible softeners and modifying agents in synthetic rubber.

These reactions are catalyzed by a large number of materials, such as oxygen, metals like copper, metal halides and salts such as boron fluoride and barium and hydrogen peroxides, soaps, fatty acids and salts, sulfides and sulfates and various other chemicals. One step in the prevention of polymerization therefore is to avoid the presence of these materials in contact with butadiene. Inhibitors are added in small percentages (0.1 per cent to 2-3 per cent) to butadiene to retard and prevent polymerization in handling, processing, and storage, the inhibitor being removed by chemical reaction, distillation or other means prior to introducing butadiene into the process making rubber. These inhibitors in general belong to two or three main chemical families; dialkyl amines, diaryl or alkyl-aryl amines, and other amino compounds, such as diaminonaphthalene, butyl- or phenylnaphthylamines; aromatic nitrogen or oxygenated compounds such as cresols, tertiary butyl and other catechols, hydroquinone, etc. Other products, generally organic hydroxy, oxy, nitrogen or sulfur products may be employed, the particular compound or mixture used depending on the experience of the individual butadiene manufacturer and the availability of different materials. In satisfactory amounts these products practically eliminate polymerization between the concentration of butadiene at the manufacturing plant and the removal of the inhibitor at the rubber synthesizing plant.

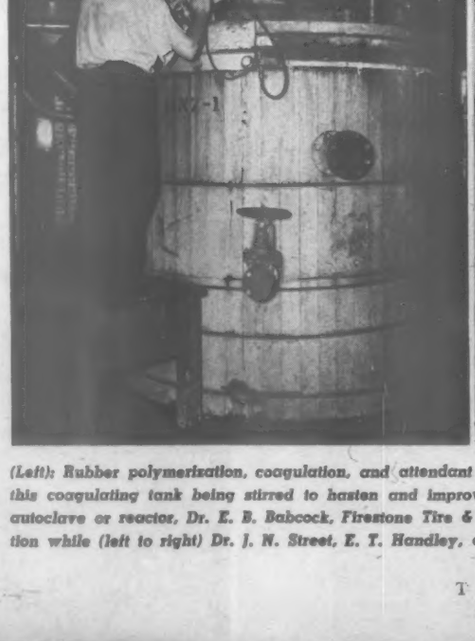
Styrene,



is also highly reactive especially in polymerization, and has been used for several years in the preparation of so-called polystyrene resins differing radically from synthetic rubber. This reaction occurs on slight provocation in the absence of inhibitors, and the same general type of chemical inhibitors are used as those discussed above for butadiene. Inhibitors for these purposes have been referred to as analogous to those used for inhibiting gum formation in motor fuels. Gasoline gum is known to be a polymerization product from the combination of olefinic and polyolefinic constituents in the fuel and therefore the reactions are somewhat similar to those occurring with these rubber intermediates. The analogy, however, is approximate and general, since easily oxidizable compounds are required in each case.

In the chemical treatment of rubber itself for the control and variation of specific properties, as stated before, the problems to be met are similar in general but vary in degree in synthetic as compared to natural rubber. Synthetic rubber is tougher than natural rubber and must be both masticated more thoroughly and treated with the same or different chemicals usually in greater quantities than is the case for natural rubber. In some instances synthetic rubber is more resistant to atmospheric oxidation—aging—than is natural rubber; therefore a smaller amount of inhibitor need be added to the synthetic type in compounding. Greater toughness or stiffness requires either more or different softeners and plasticizers in synthetic than in natural rubber. In some cases different members of the same chemical families have been found to serve synthetic-rubber processing better in the one instance and natural rubber in the other. In polymerizing and coagulating synthetic rubber, heat sensitizers, such as nitroparaffins, nitroalcohols, etc., are used to speed the "gelling" action.

For example, we will discuss briefly some of the chemicals and processing methods used for preparing the butadiene-acrylonitrile (perbunan, buna N, Hycar OR, etc.) types of synthetic rubber. Since these types have been made commercially for some years in this country, more is known about the ramifications of their effective treatment than is known about tire rubbers; many of the pertinent data on both types, but especially on tire rubber (buna S, Hycar OS, Chemigum, etc.), are held under secrecy restrictions now as a war measure, and the information therefore is not available for publication. However, it may be said that the amount of technical data, of know-how, on butadiene-styrene or tire-type rubber is relatively huge, additional information is being obtained very rapidly by a number of research development organizations



(Left): Rubber polymerization, coagulation, and attendant steps are carried out in a variety of containers, such as this coagulating tank being stirred to hasten and improve the product. (Right): Peeping through a window in an autoclave or reactor, Dr. E. B. Babcock, Firestone Tire & Rubber Co. scientist, observes the progress of the reaction while (left to right) Dr. J. N. Street, E. T. Handley, and H. H. Waters look on

working almost feverishly on these problems, and that the apparent scarcity of important data in this field is only apparent. Lack of knowledge of how to make tire-type synthetic rubber is for the time one of the least troubles with which we must be concerned. Obtaining the equipment to construct the plants for rubber intermediates, and the construction of those plants under emergency conditions in time to meet demands are many times as serious a bottleneck.

One important chemical used universally is the accelerator, which speeds up the curing process. One problem is to find chemicals which will achieve this purpose in relatively low concentrations, since higher concentrations affect tensile strength and other properties adversely. Hastening the cure, or vulcanization, speeds the throughput in the plant correspondingly and reduces the amount of material held up in process, and also of course reduces the cost of equipment and of processing for any given capacity. One family of chemicals which is being studied and used for this purpose is the dithiocarbamates, products containing both nitrogen and sulfur. The zinc salt of this acid shows particularly good

H_2NCSSH
Dithiocarbamic Acid.

results as an accelerator. A typical formula for vulcanizing—curing—synthetic rubber is the following:

Buna S	100 parts
Accelerator	q.s. (variable)
Sulfur	q.s. (variable)
Carbon black	50 parts
Fatty acid	2 parts
Softener	5 parts
Zinc oxide	5 parts

Other accelerators which may be mentioned as important are: guanidine, thiazoles (mercaptobenzo-, methylene aniline mercaptobenzo-, etc.), sulfamines, thiazolines (tetramethylthiuram mono and disulfide, zinc dimethyl dithiocarbamate, aldehyde-amine (as butyraldehyde aniline). The ratio of sulfur and of accelerator—containing sulfur—must be properly adjusted to give maximum results and effect on properties, about 2 per cent of total sulfur appearing to be optimum. A balance between tensile strength and elongation is maintained, and generally speaking a treatment which improves one deteriorates the other. And elongation of 600 per cent tensile strength of 3,500 lb. per sq. in. appears to be easily obtained in synthetic tire-type rubber.

Lower concentrations of sulfur give better results in aging of rubbers, in which synthetic rubber is better than natural rubber. Overcuring, so detrimental to natural rubber, appears not to affect synthetic rubber appreciably, while undercured synthetics are not good in oxidation resistance. Further discussion of these effects will be given in another article in this issue, on comparative properties of natural and synthetic rubbers.

Softeners and tackifiers are necessary to permit processing synthetic rubber more efficiently; coal tar, phthalates are used as softeners, and pine tar, rosin oil, cumar, etc., as tackifiers. Other softeners are alkyl and aryl sebacates, phthalates, ricinoleates, aromatic ethers, triacetin, and various proprietary products such as Santicizer E-15, Duraplex, Bardex, Carbonex S, Dipolymer oil, Abalyn, Kronisol, Advagum, Neophax A and many others too numerous to mention. Plasticizers such as aromatic mercaptans (xylyl mercaptan) work well, improving tensile strength and elongation, decreasing modulus and rebound slightly.

Softeners are of extreme importance in synthetic rubber, which is inherently more stiff and inflexible than natural rubber, in order to promote results in mastication and mixing operations, to improve flexibility and workability, properties which will be discussed later. In making butyl rubber, "elasticators," as aromatic ethers (diphenyl ether, etc.) are used to give better properties.

Added Importance of Carbon Black

Analogously, carbon black is of even greater importance in synthetic than in natural rubber. In studying rubbers made with carbon blacks ranging from 8μ to 150μ particle size it has been found that ink black (8μ-20μ), acetylene black (20μ-60μ), and channel blacks (20μ-30μ) give the greatest improvement in tensile strength. Lamp black and coarse thermal black show very little reinforcing power, with the special reinforcing blacks intermediate in effect. Hardness decreases in about the same order from the fine particled to the coarse blacks. Processing improvement increases when using the coarser blacks, acetylene black especially giving very low porosity. Hysteresis is better with larger particled blacks, decreasing as particle size decreases. Heat brittleness is aided by ink and acetylene blacks, as is tensile strength; therefore these types of black are best for tire-tread stocks, where strength and durability are at a premium. For side-wall rubber, where heat resistance is of greatest importance—because of the flexing action on side walls and consequent greater temperature rise in synthetic rubber—the finer thermal and special reinforcing grades are best. The proper knowledge of these various peculiarities is essential for the rubber chemist to make the best products for any given purpose. For example, the coarser particled blacks give higher rebound—"bounce"—yet acetylene is found to give better results than do some other blacks of larger particle size.

In vulcanizing synthetic rubber, sulfur is the most widely used vulcanizer, although other products may be used. Sulfur percentages may vary from 0.5 to 3.0 per cent or more, depending on the rubber treated and the product desired. Other products, such as accelerator tetramethylthiuram disulfide, may be used to cure synthetic rubber, especially the acrylonitrile type of oil-resistant rubber, and in most cases activators such as zinc oxide, fatty acids etc. are used. Synthetic rubber, especially butyl rubber, is less unsaturated than is natural rubber, and therefore requires less sulfur for vulcanization. Butyl rubber is still less unsaturated than buna rubbers, and requires still less vulcanization.

Smaller proportions of aging—oxidation—inhibitors are required in synthetic than in natural rubber, due to the greater saturation of the synthetic-rubber molecule. Inhibitors such as butyl- and phenyl-beta-naphthylamine are used, sometimes along with a heat-resistant antioxidant. Other inhibitors, of the classes and families mentioned above for butadiene, are also used with advantage.

Research along these lines is going forward at what now may be termed a frenzied pace. Statements made herein may be changed or nullified by discoveries already in the know of rubber chemists, publication of which is unpermissible because of emergency war precautions. Products now considered best for the various purposes may be greatly excelled by other materials later discovered. It is certain that the next few years will see developments which will make our present knowledge appear academic and very obsolete.

TABLE 1—SOME TYPICAL ACCELERATORS IN MANUFACTURE OF SYNTHETIC RUBBER

1. Heptaldehyde aniline
2. Buteraldehyde aniline
3. Diphenylguanidine
4. Di-o-tolylguanidine
5. Dibenzothiazyl disulfide
6. 2-Mercapto-4,5-dimethylthiazole 85% + 2-mercapto-4-ethylthiazole 15%
7. 2-Mercaptobenzothiazol
8. Tetramethylthiuram monosulfide
9. Hexamethylene tetramine
10. Tetramethylthiuram disulfide
11. Zinc dimethyldithiocarbamate
12. Cyclohexyl benzylthiazyl sulfenamide

With the exception of litharge, the inorganic oxides have some accelerating action. Selenium and tellurium have a little accelerating action but seem to be particularly advantageous only in raising the softening temperature. The aldehyde amines and the thiocarbamate types have a strong accelerating action and at the same time maintain the good physical properties evident in the pure gum blank containing no accelerator.—(From Ind. Eng. Chem., Nov. 1942.)

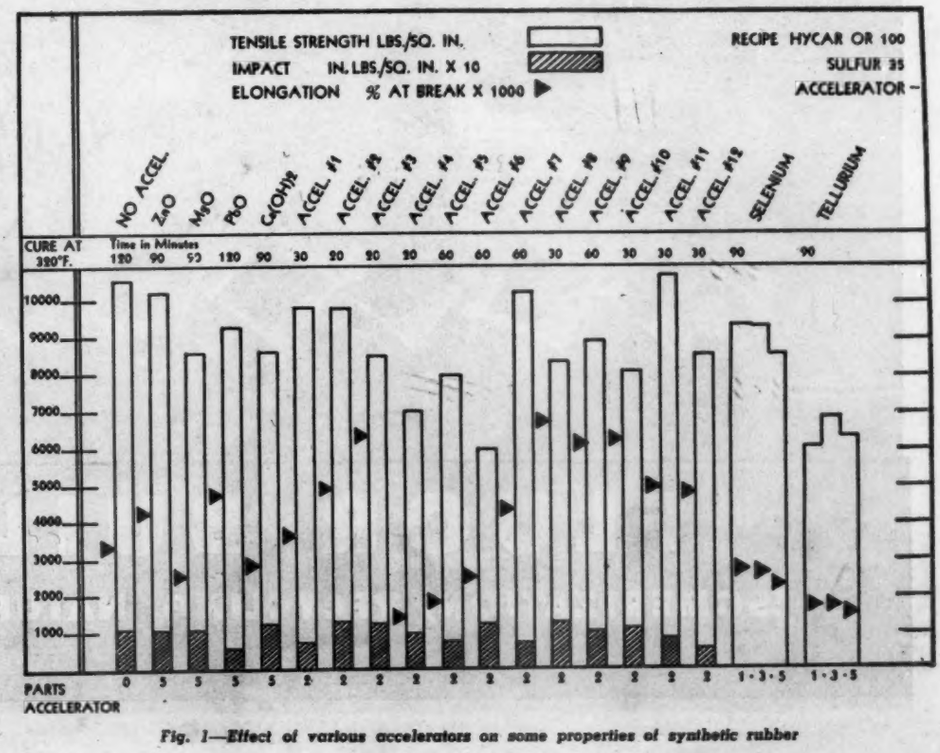
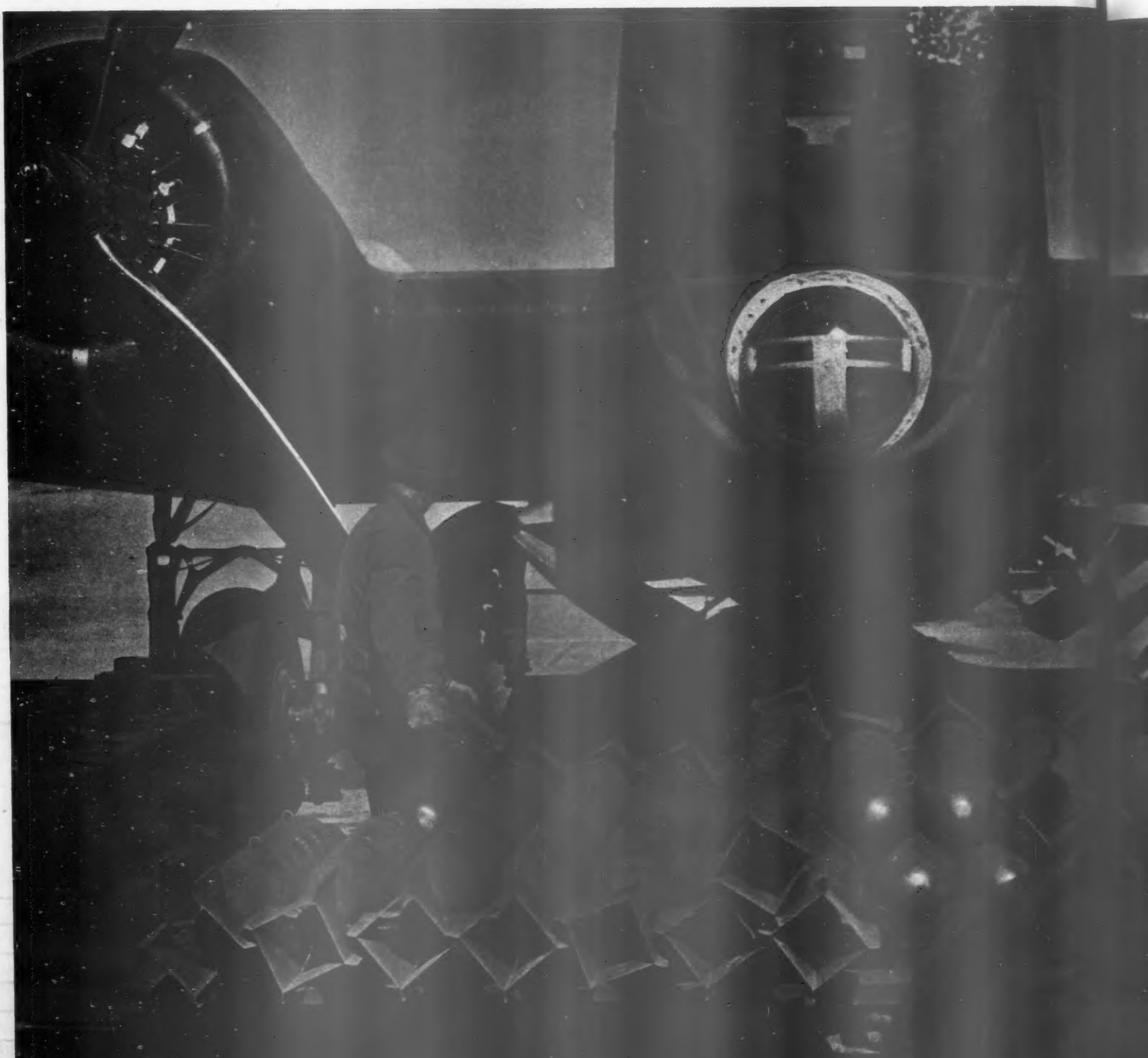


Fig. 1—Effect of various accelerators on some properties of synthetic rubber

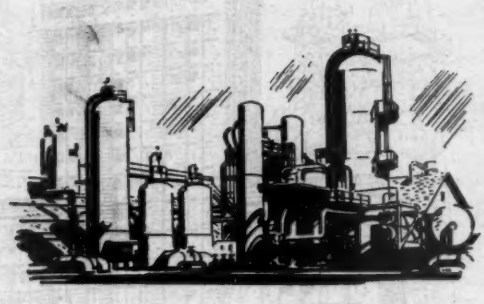
Today



FLUOR BUILDS SYNTHETIC

ISOMERIZATION, RECYCLING, NATURAL GASOLINE, GAS

Petroleum Takes Over



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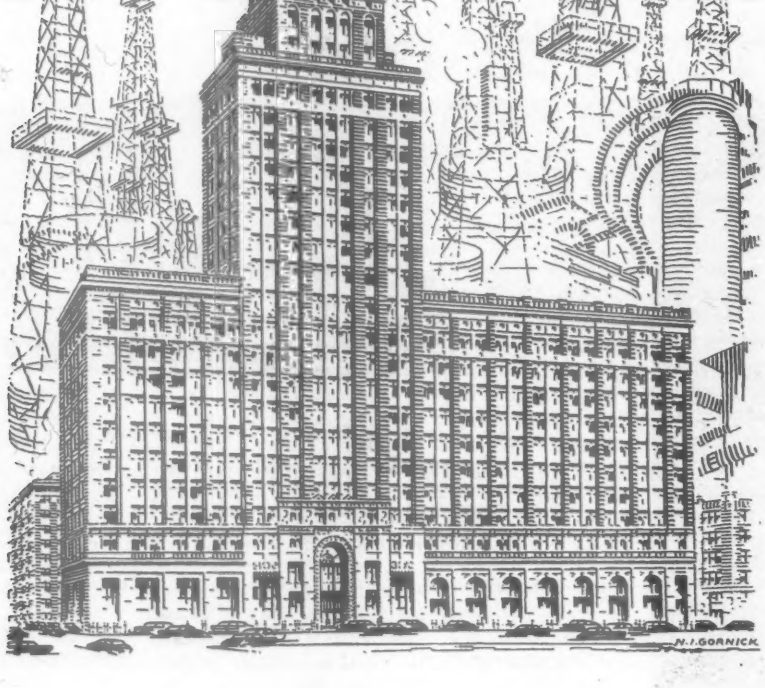

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Methods Employed in Making Synthetic Rubber

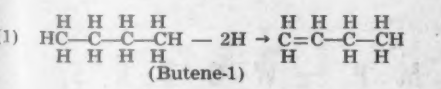
By ARCH L. FOSTER

JUST as the manufacture of natural rubber begins with the collection of the latex from the tree or shrub, so the preparation of synthetic rubber begins with the segregation and processing of the raw materials to produce the various major intermediates which are polymerized to form rubber-like materials. The definition of synthetic rubber in this discussion will be essentially that enunciated by Midgley and others, that "synthetic rubber is any extensible material which has the property of resisting extension and, when the extending force is removed, has the power of resuming essentially its original form and shape."

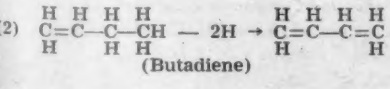
The essential steps in the production of synthetic rubber are: Preparation of the olefins, diolefins, etc., which may be made from hydrocarbons, alcohols, coal tar and other sources; purification of these intermediates; polymerization of these intermediates under appropriate conditions; coagulation of the rubber particles from the synthetic latex formed by polymerization; processing the crude rubber to make the finished article of commerce. The final processing includes the conditioning of the physical properties of the crude rubber, addition of modifiers of several types and for many purposes, all affecting the properties of the finished material. These steps include especially vulcanization, acceleration, plasticizing, elasticizing, inhibiting, softening and sometimes other steps influencing importantly the final product's properties and its usefulness.

The essential intermediates required for the synthesis of rubber-like polymers and condensates are: diolefins, such as butadiene and pentadiene; styrene or other vinyl benzenes; acrylonitrile or vinyl cyanide; chloroprene; esters of acrylic or methacrylic acid; ethylene dichloride; inorganic polysulfides; polyhaloalkyl and alkylene ethers; vinyl halides, especially chlorides, and some others which will be mentioned only incidentally here. For the purposes of this condensed summation of synthetic rubber, these materials include all those specifically essential to our present rubber production. Also, since preparation of the major intermediates is discussed in more technical detail elsewhere in this issue, that phase of the subject will be touched here lightly.

The two most widely used methods for butadiene making are the dehydrogenation of butene and butane, and the dehydration-dehydrogenation of ethyl alcohol. The first is used more in this country, the second almost exclusively in Russia and, it is believed, in Germany for preparing butadiene commercially. In processing butane either a two-step procedure, or a so-called one-step process may be employed, the same reactions being carried out in either case. The first step is reduction of butane to butene,



In a succeeding step butene-1 is further reduced by the removal of another molecule of hydrogen,



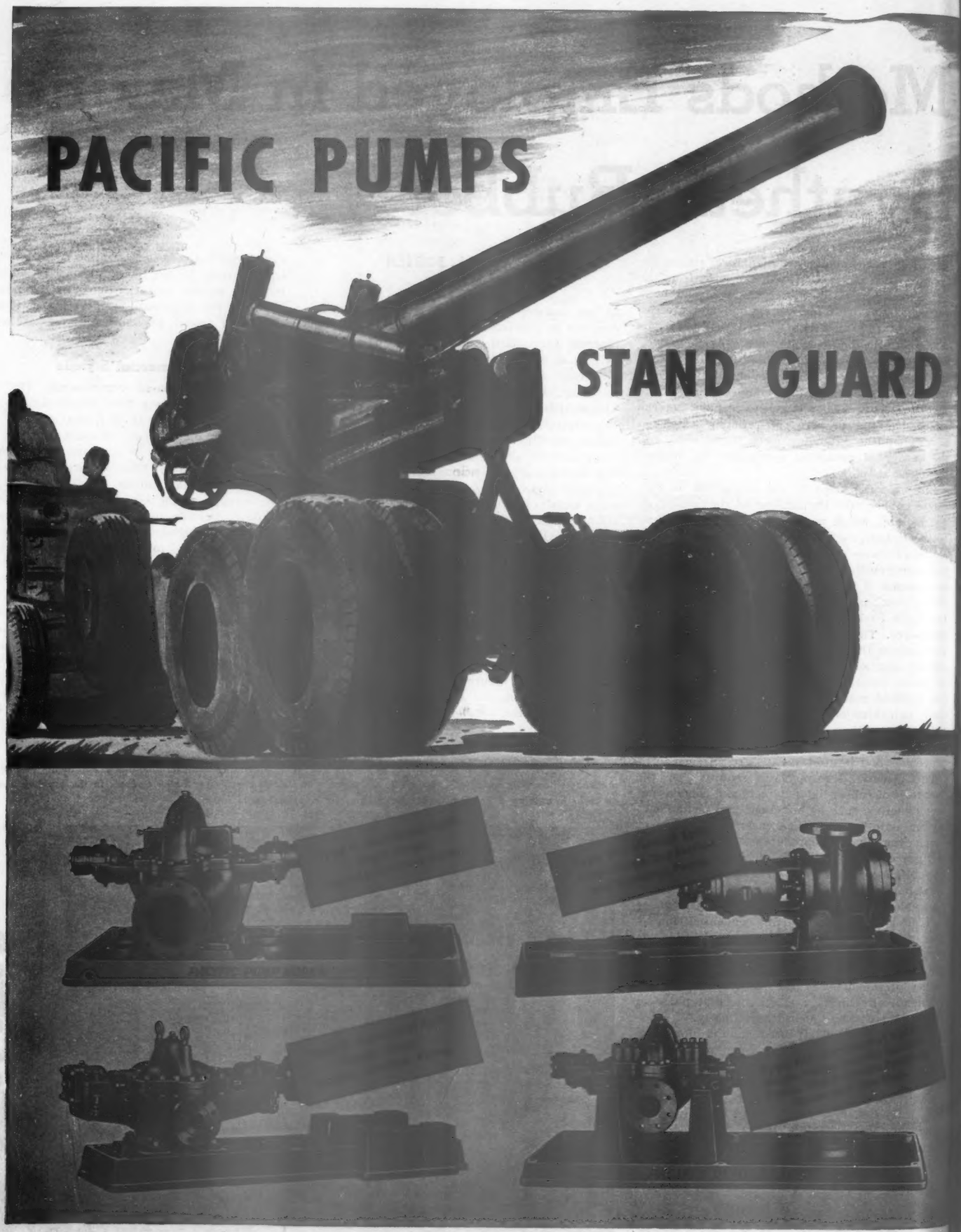
In the one-step process both reactions are carried out in the same step, in the nature of the reaction necessitating lower yields or more recycling of charge, in the opinion of many technologists; both processes are employed commercially, however, with considerable success. This dehydrogenation may be accomplished either by pyrolysis alone or by catalysts such as alumina, chromic oxide, bauxite or mixtures of these and/or other dehydrogenation catalysts. The use of catalysts permits somewhat lower temperatures and considerably lower pressures, along with higher yields than those obtained by pyrolysis alone. Thermal cracking (pyrolysis) of naphthas is used in the "quick" butadiene program, involving formation of a large percentage of byproducts and relatively low yields with our present technology. The term "quick" refers to the means of obtaining butadiene and not to the diolefin itself, butadiene from that process being identical of course with that obtained by any method. Because its high reactivity makes it difficult to handle without objectionable polymerization reactions occurring, butadiene is treated, after purification and concentration processing, with a polymerization inhibitor such as phenyl-beta-naphthylamine which may be removed by distillation before polymerization to form rubber latex, or may be left in the product to act as an inhibitor against oxidation-aging of the product. Normally the inhibitor is removed since it interferes wth proper polymerization when that reaction is desired.

Commercial Styrene

Styrene is prepared commercially (by Dow Chemical Co. process) from nitration-grade benzene (boiling range 1° F.) and ethylene gas, which latter may be used in concentrations with other gases as low as 38 per cent, though higher purities give more efficient conversions. Aluminum chloride, anhydrous, is the catalyst and the reaction is the conventional Friedel-Crafts', forming ethylbenzene in practically theoretical yield, after methods for conversion of byproduct polyethylbenzenes to the mono variety were perfected. The ethyl side chain is dehydrogenated to vinyl by mixing the ethylbenzene with highly superheated steam. Concentration of the reaction mixture to isolate the styrene offered some difficulties, especially the elimination of phenylacetylene formed by over-dehydrogenation of the side chain. Small amounts of sulfur were found to prevent polymerization of the monomer to polystyrene, a clear solid resin, during distillation to concentrate the styrene. Tertiary butyl

(Continued on Page 60)

In a battery of reactors or autoclaves, such as these at Firestone's plant, intermediates butadiene and styrene are reacted to polymerize to rubber latex. Operator on left is checking a batch of latex in the making; operator on right is making a batch of synthetic rubber, by coagulation of latex



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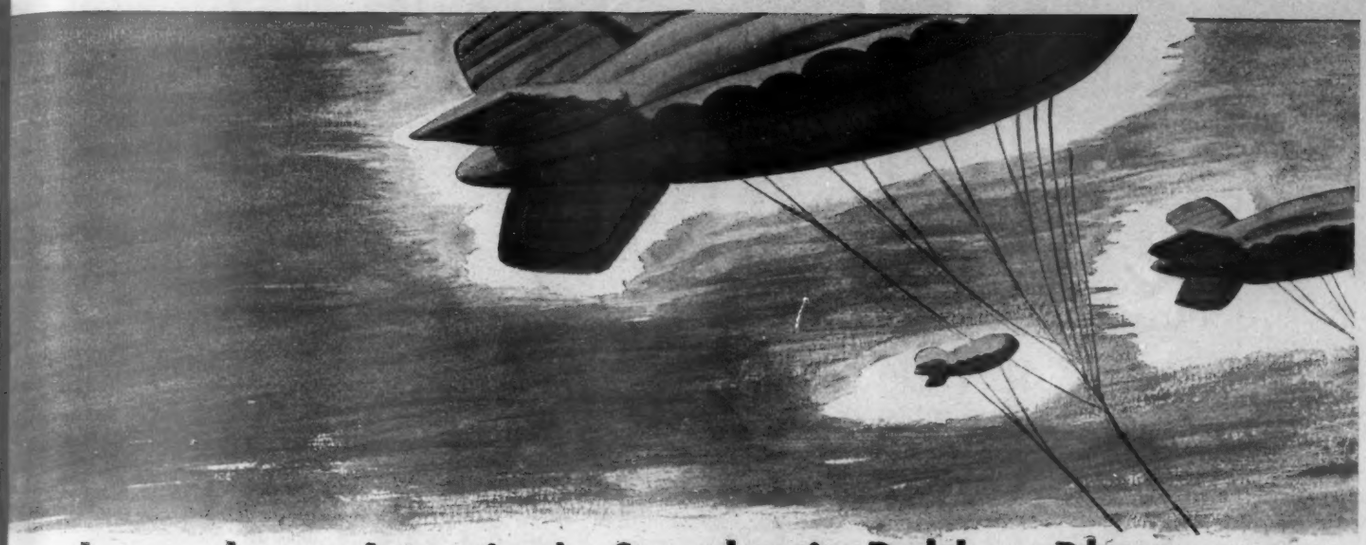

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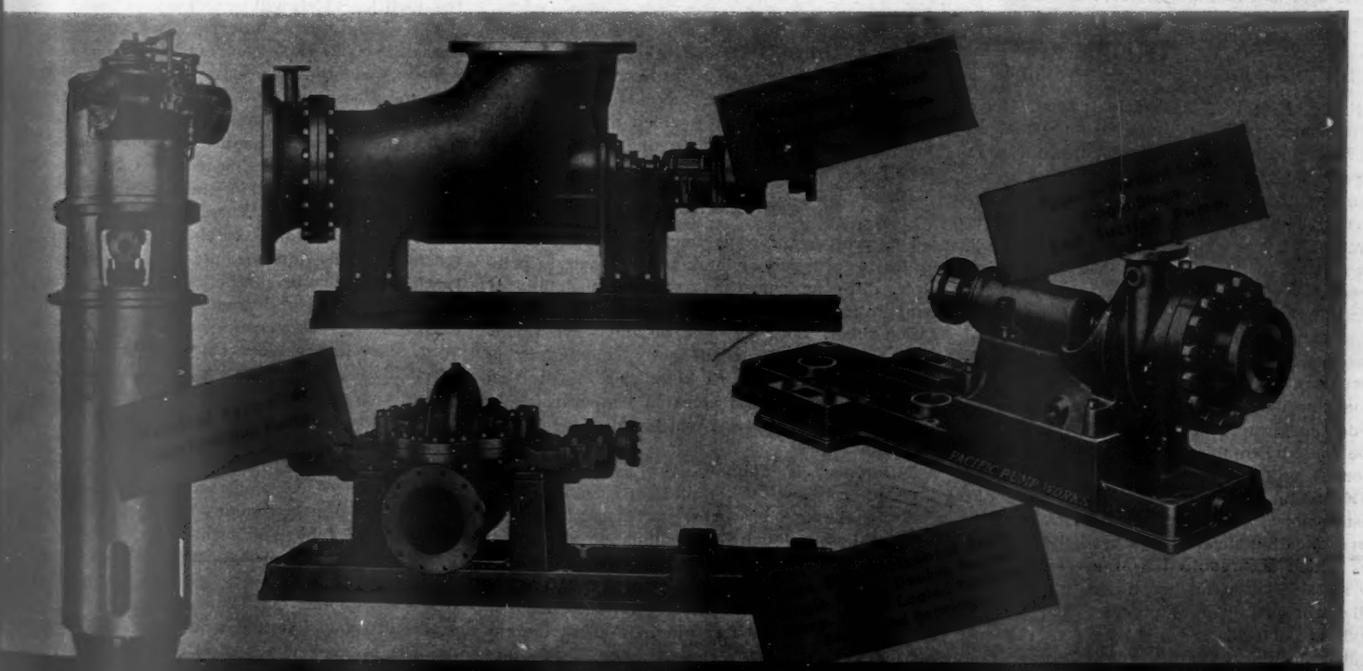


PACIFIC *Engineered* PUMPS

(Left): Wringer-drying synthetic rubber prior to rolling it into sheets. (Right): Synthetic-rubber "crumbs" exiting from a dryer on its way to be sheeted in a rolling machine

catechol is used as a stabilizer in polymerization and copolymerization operations.

Acrylonitrile is prepared from ethylene or acetylene and sodium cyanide,

$$(3)\quad \underset{\text{Ethylene}}{H_2C{=}CH_2} + NaC{\equiv}N \rightarrow \underset{\text{Acrylonitrile}}{H_2C{=}CH{-}C{\equiv}N},\ \text{etc.}$$

(By displacement of an H atom)

$$(4)\quad \underset{\text{Acetylene}}{HC{\equiv}CH} + HCN\ (NaCN + HCl) \rightarrow H_2C{=}CH{-}C{\equiv}N,\ \text{etc.}$$

(By addition to acetylene)

Acrylonitrile may also be made by other methods as the ethylene oxide-hydrogen cyanide route.

Acrylic acid and methacrylic acid are indicated by the formulas

$$CH_2{=}CH{-}COOH,\ \text{and}\ CH_2{=}\underset{\displaystyle CH_3}{\underset{|}{C}}{-}COOH,$$

respectively. Esters of these acids are and have been for some years under active study and research to determine their essential usefulness in rubber synthesis, and the special properties which they impart to the final product. Most of this information is blanketed by secrecy conditions in the present emergency and cannot be disclosed, but the effect of using these materials is important in our future rubber technology. Resins are made by the polymerization and/or condensation of organic acrylates and methacrylates, and the properties of these resins are well known and important in plastics preparation. Both acids may be considered derivatives of acetylene or ethylene and formic acid, H—COOH. Acrylic acid may be made by combining acetylene with formic acid, or by uniting ethylene with carbonic acid, NH_2COOH, eliminating a molecule of ammonia. The esters are easily produced by treatment with the corresponding alcohols or alkyl halides of the groups which are required in the ester needed, under suitable esterification treatment which is a well-established general process.

Ethylene dichloride is made by reaction of two molecules of chlorine with ethylene, or one molecule of chlorine with acetylene under carefully controlled conditions. Two atoms of chlorine replace two hydrogens in ethylene and two molecules of HCl are formed which in practice must be salified as calcium or sodium chloride in order to eliminate or reduce further side reactions which otherwise may continue during processing and impair yields obtained.

Chloroprene is prepared from coke, limestone and salt. Limestone and coke are heated together to yield calcium carbide, the "carbide" long known, which by hydrolysis yields acetylene. Two molecules of acetylene may be condensed to form butadiene, one of the methods by which that material may be synthesized. Or, one molecule of acetylene is combined with hydrocyanic acid, HCN, by passing the acetylene through a solution of sodium cyanide which has been acidified with HCl—giving free HCN—to yield acrylonitrile. Or, two molecules of acetylene are condensed to form vinyl acetylene,

$$\underset{\text{Acetylene}}{2HC{\equiv}CH} \rightarrow \underset{\text{Chloroprene}}{H_2C{=}\underset{\displaystyle Cl}{\underset{|}{C}}{-}CH{=}CH_2}$$

Several other products are employed in synthesis of various rubber synthetics, the manufacture of which are established commercial processes. These products are supplied by the chemical industry by processes which at present are of no immediate interest to the petroleum or rubber industries.

Polymerization

The processes for polymerizing these unsaturates to form rubber latex are the same in principle, differing sometimes widely in details of temperature, agents and catalysts, and polymerization times. Both styrene-type and acrylonitrile-type rubber latex are made by copolymerizing these intermediates with butadiene in emulsion form under somewhat elevated temperatures in the presence of catalysts which induce or hasten the reaction.

Differences of opinion exist as to the best type of emulsion to employ. German patents indicate the use of soaps, such as saponin or fatty-acid salts such as sodium or potassium stearate, oleate, etc., or sulfo-fatty acid salts, along with 10-15 per cent water, which is too small a percentage of water to dissolve all the soap employed. Other emulsifiers include diethylaminoethyloleylamide acetate and a long list of other complex organic products. American practice is to employ a more dilute latex, or the copolymerization may be carried out in concentrated form and water added later to dilute the reaction mixture to the concentration desired. Polymerization catalysts include hydrogen peroxide and other peroxides, persulfates, organic nitrocompounds such as 5-nitro-2-styrilbenzimidazol, benz-p-nitraniline, p-nitrobenzal-p-nitraniline, and similar complex materials. The catalyst is used generally in small percentages less than 1 per cent, and various other additives may be used to improve emulsion characteristics, promote suspension of the rubber in latex form and for other purposes.

One formula for the copolymerization of butadiene with either styrene or vinylnaphthalene to form the buna S type rubber, or with acrylonitrile for buna N type rubber is:

150 parts of a mixture of butadiene and styrene or acrylonitrile
15 parts of soap (sodium or potassium stearate, or other emulsifier)
and 10 parts water, or
5 parts water, with saponin and three parts trichloracetic acid):

The usual proportions of butadiene and styrene of acrylonitrile are 3 parts of butadiene, to 1 part of styrene; 4 to 7 parts of butadiene to 6 to 3 parts of acrylonitrile. These ratios may be varied to improve individual properties or to minimize undesirable properties at the will of the manufacturer; the innumerable combinations of intermediates, accessory chemicals, minor intermediates with reaction conditions will require years of intensive, systematic research to evaluate, and on the careful, coordinated investigation of this enormous field depends much of our technology of synthetic rubber for the future, and the qualities which will be attained in that rubber.

These mixtures of intermediates and aids are placed in reactor vessels and allowed to react under relatively low pressures and elevated temperatures varying from nearly atmospheric to 125° F. or higher. In making butyl rubber, however, much lower temperatures are employed, as low as minus 150° F. being mentioned, using solid carbon dioxide to attain these temperatures in commercial practice. When the reaction is considered complete, the vessel is opened, and unreacted volatile intermediates are removd. The reaction mixture or synthetic latex is transferred to a coagulator, and treated at atmospheric or slightly higher temperature with a coagulant catalyst. Simple organic acids such as acetic give excellent results in this process. The rubber molecules have already been formed by copolymerization and are present in the milky latex as finely divided rubber particles, essentially as the natural product exists in the sap of the rubber tree when collected. Vigorous stirring promotes and speeds up the coagulation action, and the "crumbs" of rubber so formed are washed with water to remove nonrubber materials, as catalyst, etc., partially dried at low temperatures and frequently under partial vacuum, rolled into sheets in somewhat the same manner that paper pulp is sheeted, cut into sheets of the desired size which are further processed to produce the finished rubber of commerce.

Processing Crude Rubber

Before the processing of crude rubber sheet to make the finished rubber, certain modifiers are added to vary the properties of the product, to improve some of the processing steps. During

(Above): Tread stock for tires being sheeted in a special die press. (Right) Calendering unvulcanized rubber; rubber is processed and cut into strips for reinforcing the tire

the process other modifiers may be added for special purposes.

The first step in processing the crude sheet is that of mastication or milling, which is preceded by the addition of carbon black, softeners and plasticizers. Natural rubber is placed in a working mill, in which it is passed through a system of rollers the surfaces of which may be irregular in shape, or may be grooved so that grooves mesh in the same way that gears mesh. These rollers are set at predetermined distances apart and the rubber is kneaded over and over again to make it plastic, softer and more workable, and to mix it thoroughly with the various additives used. These rolls for natural rubber are heated to superatmospheric temperatures, 180°-200° F. being a typical range. Synthetic rubber, of both the tire and the oil-resistant types, is harder and less tacky—stringy—than natural rubber and requires more softener and more milling. Present practice sets the rolls closer together—a "tighter" mill—than for natural rubber and the mill is kept at lower temperatures with atmospheric to 165° F. being a typical range. The rubber must be prevented from becoming too hot; under such conditions it becomes what the rubber maker calls "short"; that is it will not string out when pulled by the mill rollers, but breaks on a short pull, "laces" at the edges and may even fall off the rolls if allowed to heat during the process, or if operated at conditions which are good for the natural product. Softeners such as xylyl mercaptan or other aromatic mercaptans are added generally in amounts slightly less than 1-per cent. Tire-type rubber especially may be plasticized in a current of hot air if conditions are carefully controlled. Without exact control, however, this method may even harden the rubber on the mill.

Synthetic rubber requires considerably more "working" on a tighter mill than natural rubber. Therefore a greater milling capacity must be provided for any given throughput, the material takes longer in processing. Types of softeners have been mentioned in another article in this issue and will not be repeated here except for illustration. Oil-resistant rubber requires larger portions of softener, materials such as soft coal tars, alkyl, alkylene and alkoxy sebacates, phthalates, phosphates and glycollates (butyl phthalyl butyl glycollate- Santicizer B-16; ethyl phthalate ethyl glycollate- Santicizer E-15; methyl phthalate ethyl glycollate- Santicizer M-17, for example). Once broken down by milling, synthetic rubber is available without further processing for mixing at any later time.

Rubber Compounding

A typical mix, for example, for making up finished oil-resistant rubber is:

Crude sheet-butadiene-acrylonitrile	100 parts by wt.
Zinc oxide	5 parts by wt.
Stearic acid	1 part by wt.
Sulfur	1.5-2.5 parts by wt.
Accelerator	0.5-1.5 parts by wt.
Pigment	50 parts by wt.

Starting with a premasticated—milled—stock, the oxide, softener—stearic acid—and accelerator are added and the mixing continued until all are thoroughly incorporated in the rubber. Plasticizer may then be added and the mix worked until uniform. Because of the extreme importance of complete mixing with the pigment, such as carbon blacks, the black may be added piecemeal, a portion at a time, thoroughly incorporating each portion before the next is added. When properly mixed the cut edge of a stock mixed with channel black should be bright and glossy. If it is dull or rough or if unmixed particles of black are found on examination of a cut edge the mix must be passed through the mill again until properly homogenized. In mixing different stocks for compounding to meet a given specification, tackifiers such as methylethyl ketone, butyl acetates, etc., are used, to give the desired stickiness.

The nature and physical structure of the blacks used have a profound influence on the properties of the finished rubber. Blacks range in particle size from the fine-particled channel blacks, divided into grades one to nine in ascending order of size, through furnace blacks produced in various ways—referred to as reinforcing semireinforcing, thermal decomposition and by other terms—to lampblack,, the largest particle size. The smaller the particle size the harder the black, the higher the heat generation in the rubber compounded with it, in service; therefore with the natural tendency of synthetic rubber to generate more heat during flexing the larger size, softer blacks are more desirable. However, with larger particle size abrasion (wear) resistance decreases; therefore a compromise must be made, and that combination of blacks which improves the most desirable quality will be used. In light-

er service such as passenger-car tires heat generation is less severe than in bus and truck tires. So, in passenger-car tires the fine-particled blocks may be used which, though generating more heat, also give better wear resistance and longer life. With truck-tire rubber softer blacks will be used, losing something in wear resistance to gain in lower heat generation and thus decreasing the decomposition rate of the heavy-duty tire. Generally, larger-particled black is used in synthetic than in natural rubber. Channel black tends to stiffen the rubber which thus generates more heat in flexing.

During this last mixing prior to final preparation of the finished product, the vulcanizer is added. Elementary sulfur tends to lessen heat resistance and increase the consequent deterioration due to heat, therefore the trend is toward

(Continued on Page 67)

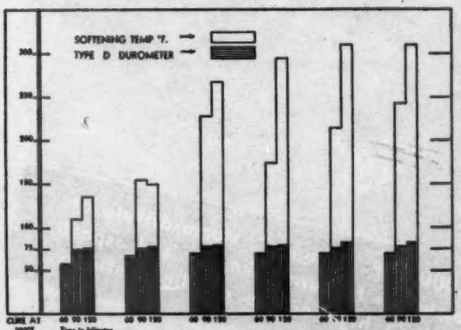
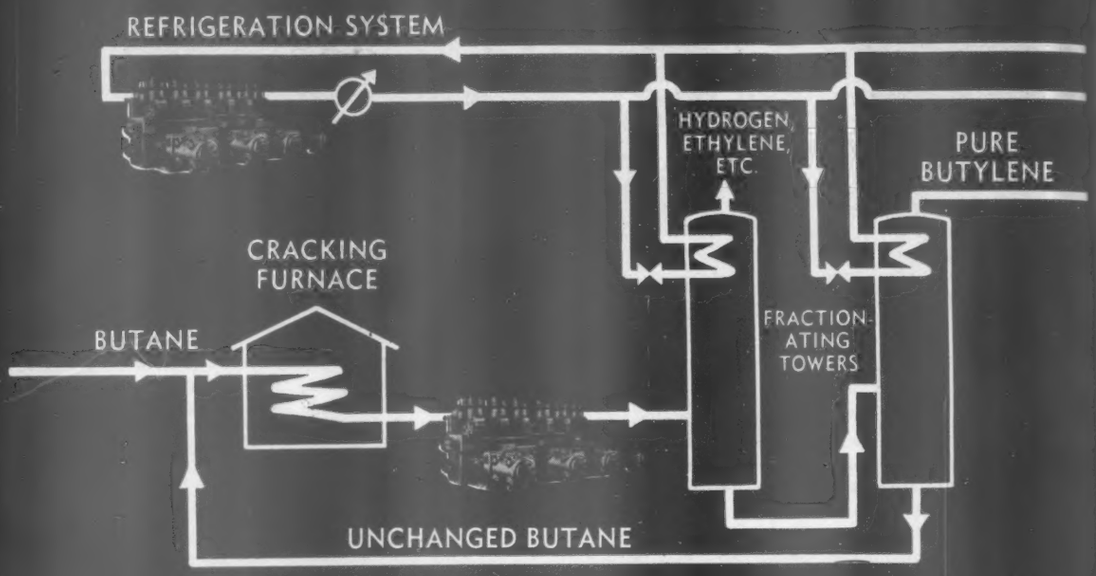


Fig. 1—Effect of time of cure on the softening temperature (heat resistance) of synthetic rubber. Longer curing time increases softening temperature of synthetic rubber; as curing time is increased natural rubber softening temperature (also hardness) increases, then falls to a lower value beyond a given maximum time

CLARK COMPRESS



Here two Clark 3,000 H.P. "Angles", steam-driven, are furnishing compressed air to burn coke, tar and asphalt from the catalyst, in a high octane gasoline refinery.

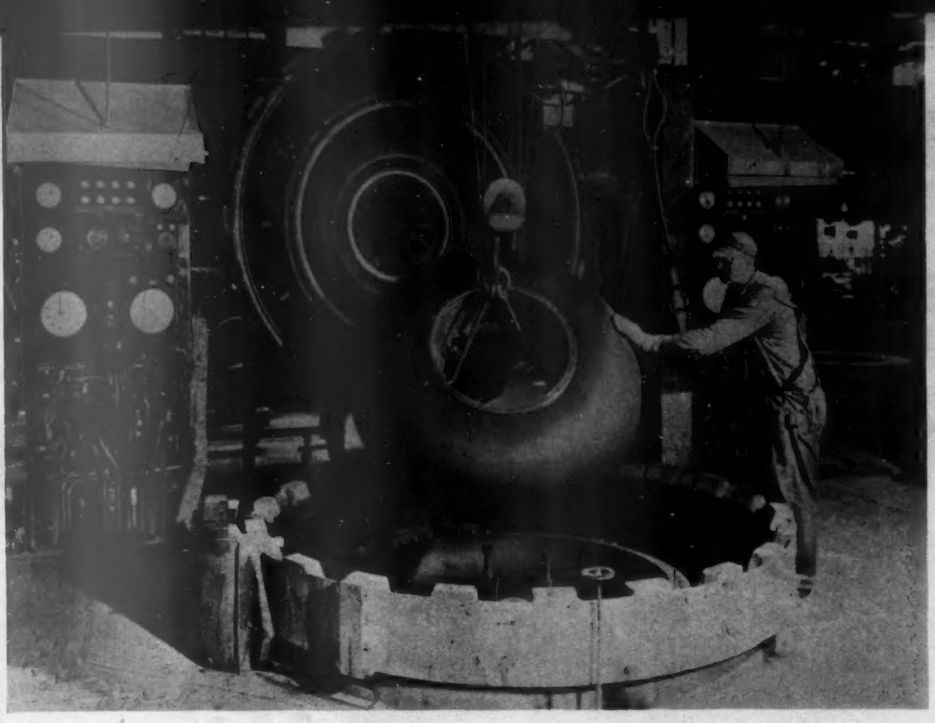
AMONG the scores of processes so far developed in making synthetic rubbers of the various types — one of the heavy volume roles will be that of the manufacture of Butadiene, the petroleum product from which the Buna N and Buna S types of rubber for automobile tires will be produced.

The simplified flow chart shown above indicates the part that CLARK Compressors will play in many leading Butadiene plants. They will be used for compression of gases for charging the fractionating towers and for refrigeration.

These processes are typical of the services that CLARK Compressors are being called on to perform in all types of synthetic rubber plants. In one type of plant CLARK Compressors will produce temperatures in the neighborhood of 150 degrees below zero.

CLARK Compressors are also used in the manufacture of Styrene from petroleum—the

CL



The finished product coming from the vulcanizing unit where it is formed to exact dimensions. A 56-in. tire intended for airplane service.

vulcanization with sulfur compounds with a minimum of elementary sulfur, even to the extent of no added sulfur as such. Because of the lower unsaturation of synthetic rubber less sulfur is required in any case for proper vulcanization, about 2 per cent being considered a desirable maximum, less being used if practicable. Table 1

TABLE 1—EFFECT OF PLASTICIZER ON OIL-RESISTANT SYNTHETIC RUBBER (XYLYL MERCAPTAN)

Base formula.—Perbunan 100, zinc oxide 5, stearic acid 1, soft coal tar 8, ozocerite wax 1.5, channel black 45, benzothiazyl disulfide 1.25, diphenylguanidine 0.25, sulfur as shown.

Formulas:				
Perbunan, cold mill breakdown	100	100	....	....
Perbunan, Banbury, 10 min., 165° C., 0.90 part xylyl mercaptan	....	....	100	100
Sulfur	1.5	3.0	1.5	3.0
Test data:				
Stress-strain (cured 60 min. at 141.5° C.):				
Tensile, lb./sq. in.	3,560	3,000	2,980	3,140
Elongation at break, %	650	380	660	440
Modulus at 300% elongation	1,180	2,100	910	1,700
Compression set in %, A.S.T.M. 395-40T method B, 30% deflection (cured 75 min. at 141.5° C.)	20.4	14.5	32.9	22.2
Rebound in %, Goodyear-Healy pendulum, 15° angle (cured 75 min. at 141.5° C.)	46.4	43.2	43.2	40.2

shows the effect of plasticization of oil-resistant rubber mixes; Table 2 shows the effect of different accelerators (organic sulfur compounds) on heat resistance of oil-resistant rubber. For imparting better plasticity (lower hardness) at subnormal temperatures the organic phthalate, phosphate and sebacate softeners appear to give excellent results, comparatively.

When all accessory chemicals have been added, and the batch is properly compounded and mixed, the rubber is ready for vulcanization, and in the case of tires, tubing and most other main products the final article is assembled in its exact form before vulcanization. In tire making, the cord, the wires in the bead and reinforcing ingredients are assembled in a form by a workman, the rubber is placed in position around and through these reinforcings, in the casing is placed a bag and the whole is put into a press, in the inside of which is a die in which is cut the entire pattern which is to be impressed in the casing. The press is closed and locked and steam or other heat is turned on the assembly, attaining temperatures up to 300°-400° F., while pressures up to 20 tons per square inch or higher, admitted to the bag inside the casing, force the whole uniformly into the form and its die, the outside rubber reproducing in exact detail the pattern in the die. The casing under the temperature and pressure employed is allowed to "cook" or "cure" for periods up to 2 hours for synthetic rubber, after which pressure is released, heating is discontinued and the finished casing is removed from the form, the rubber fully vulcanized.

One of the characteristics of synthetic rubber

TABLE 2—FORMULA FOR AND CHARACTERISTICS OF HEAT-RESISTANT SYNTHETIC RUBBER

Base formula.—Perbunan 100, zinc oxide 5, stearic acid 1, semireinforcing furnace black 75, soft coal tar 20, accelerator and sulfur as shown.

Formulas:		
Benzothiazyl disulfide	1	....
Tetramethylthiuram disulfide	....	3
Sulfur	1.5	....
Test data:		
Stress-strain (cured 60 min. at 141.5° C.):		
Tensile, lb/sq. in.	2,140	1,790
Elongation at break, %	530	590
Modulus at 300% elongation	1,525	1,070
Shore hardness	63	60
Air oven, 50 hr. at 121° C.:		
Tensile retention, %	101	108
Elongation retention, %	41.5	78.0
Shore hardness increase, %	10	7
Compression set in %, A.S.T.M. 395-40T, method B, 30% deflection (cured 75 min. at 141.5° C.):		
22 hr. at 70° C.	20.9	18.4
22 hr. at 121° C.	66.5	28.3

is that it requires longer periods for curing or vulcanizing than does natural rubber. Similarly, synthetic rubber does not overcure so easily as does natural rubber which latter, under extended curing periods, reaches a maximum of strength and other desirable qualities, then when that maximum period is exceeded, becomes softer and tends to break down. Overcuring tends to improve some properties of synthetic rubber but the curing conditions must be controlled carefully if optimum results are to be achieved.

Because of its special properties, butyl rubber may be considered briefly as to its specific compounding requirements. Polyisobutylene, because

(Continued on Page 78)

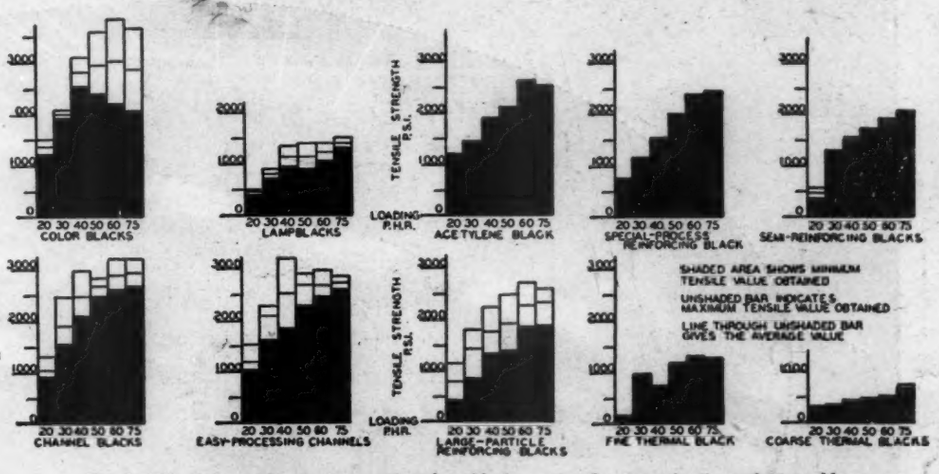


Fig. 2—Effect of quantity and type of carbon black on tensile strength of synthetic rubber

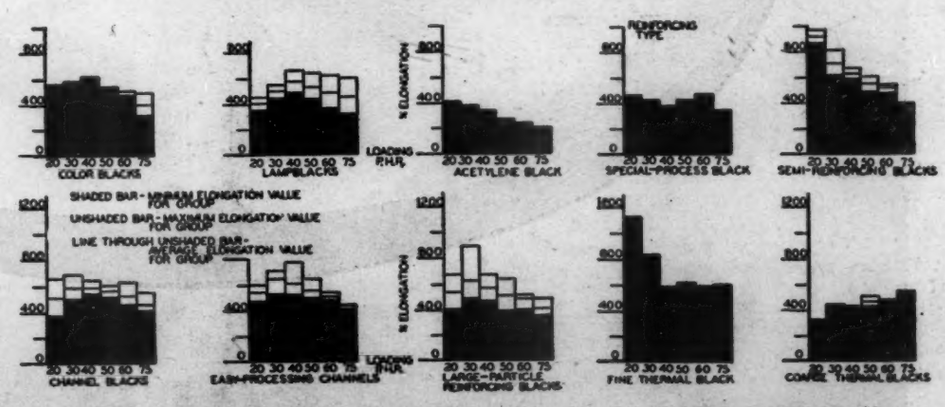
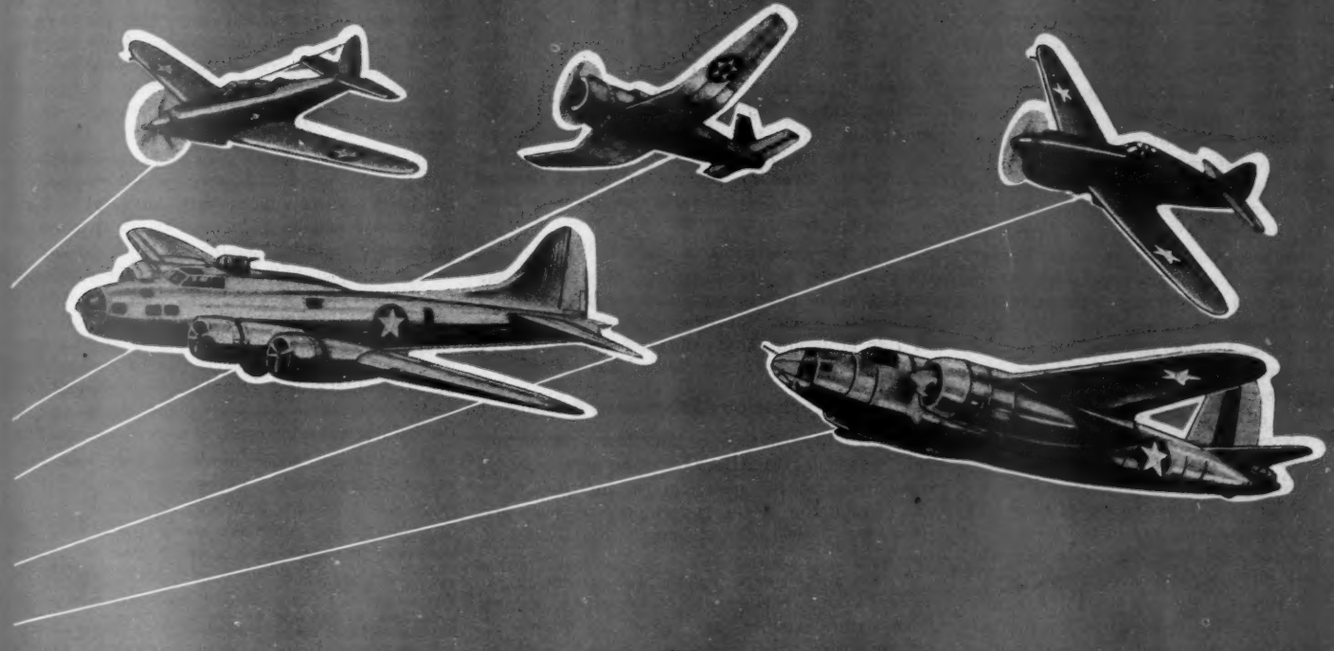


Fig. 3—Effect of quantity and type of carbon black on elongation (stretchability) of synthetic rubber

Fuel for Fighters

... for Freedom!



From gas and oil fields throughout the Mid-Continent, aviation base stocks and pure liquid hydrocarbons, recovered and fractionated in Hudson-designed and built plants, are flowing into 100 octane aviation gasoline in ever increasing volume.

Work in progress includes a toluene concentrating unit; a butadiene plant; a cycling plant to produce eight fractionated products; complete facilities on a pipe line for removal from natural gas of hydrogen sulphide, carbon dioxide, recovery and fractionation of natural gasoline and the dehydration of the dry gas.

Design, drafting, purchasing and construction facilities are at present available for additional projects.

HUDSON ENGINEERING CORPORATION

Engineers and Constructors

FAIRVIEW STATION • HOUSTON, TEXAS

Buna and Butyl Rubbers Excel Natural in Many Qualities

By J. A. BRITTON, JR.
Chemicals Department, Stanco Distributors, Inc.

THE development of the American synthetic-rubber industry is marked by two periods, that before Pearl Harbor, and the present period of energetic expansion. The happenings of the latter period are bound to leave a very definite imprint on American industry.

In the early period, synthetic-rubber production was expanding along lines normal to the growth of any entirely new synthetic product. Our market had not reached the state where it was able to absorb the large quantities of these synthetic products necessary for low-cost operation. At that time an all-around satisfactory synthetic-rubber tire had not been made, nor was it in sight; (tires were, and will be, the big tonnage consumer of rubber). As a consequence, only costly synthetic rubbers, possessing some special property, useful to effect an economic saving, found a market. (A contrast to the governmental-fostered industry as practiced in Germany.) With this set of conditions there existed a slow but steady expansion in the production of those synthetics that possessed long life in the presence of oils, that resisted oxidation chemicals, high-voltage electrical currents, and were tough.

With the threat of war these "specialty" rubbers took on added importance for industry and for combat services, and a few companies, foreseeing increased demand, formulated plans for expanded production. Compared with the enormous investment required to manufacture our normal rubber requirements, this was but a small start. Even for several companies to supply the necessary capital outlay would have been a financial strain.

With the declaration of war and the subsequent events, synthetic rubber became a must backed with government sponsorship. Buna-S, best-suited rubber for tires, received first place in this program. Butyl rubber, the most recent addition to the list of synthetics, was second.

Rubber Technology Progresses Rapidly

Accessibility, abundance and low cost of the raw materials (butadiene, styrene and isobutylene) required for manufacture, contributed to the formulation of the government program for producing 700,000 tons of buna S and 132,000 of butyl.

Within a span of a few months, American industry, with a background of knowledge gained from natural rubber, has raised the quality of passenger-car tires made with buna-S until it equals that of the natural-rubber tires; heavy-duty truck tires, although improved, still do not give the extended service desired. Butyl-rubber tires at first withstanding only 1,000 miles before failure, now give 20,000 miles of service at 40-mile speeds.

In 2 or 3 years' time, the American rubber industry will possess a store of information on synthetic rubber which would have taken 18 to 20 years to acquire in normal times. In addition, production facilities capable of supplying any domestic demand will be available. On the other hand, postwar demand will be predicated on the outstanding properties of these new materials of construction and their cost. As contrasted to the good physical properties of natural rubber, the outstanding chemical properties of synthetics contribute something that is lacking in the natural material, opening new fields of utility.

As we know these products, they rate categorically as follows:

	Natural	Synthetics
Most bounce	Best	Fair
Low heat generation	Best	Fair
Stretch	Comparable	
Tensile strength	Comparable	
Toughness	Comparable	
Resistance to swelling by oils	Poor	Best
Resistance to oxidation, weather, temperature	Fair	Best
Inertness to strong chemicals	Poor	Best
Inertness to electrical corona	Fair	Best
Impermeability to moisture and gases	Fair	Best

The properties of the several known synthetics vary in such a degree that it is now feasible to impart a variety of desired physical and chemical qualities to manufactured goods. This, then, points the role of synthetics in making new and better products. Most of all, it would be incorrect to leave any idea that synthetic rubber will completely replace all natural rubber; of the thousands of rubber products, many require natural rubber for best performance.

The following pages detail the outstanding features of four of the well-known synthetic rubbers, indicating how they vary one from another, with suggestions of their utility. Two of them, butyl and vistanex (nonvulcanizing), depend entirely upon petroleum sources for raw materials; the other two, perbunan and buna S, require petroleum-derived products for only part of their raw materials.

Vistanex

Vistanex is a polymer of isobutylene, a petroleum hydrocarbon, and is substantially lacking in unsaturation (zero iodin number), which accounts for many of its properties. It cannot be vulcanized. This product, first known in Germany as opanoll, was developed in the United States by Standard Oil Co. (New Jersey). It is made by very rapid polymerization at quite low temperatures using boron fluoride or aluminum fluoride as a catalyst.

Vistanex is available in several grades: low molecular weight, 5,000 to 15,000; medium molecular weight, 30,000 to 150,000; and high molecular weight, above 150,000. The first is a thick, tacky, semisolid fluid with but little tensile

Heating oven for curing test pieces used in determining elongation

strength; the others are plastics with tensile strength increasing with molecular weight.

Physical Properties

Vistanex has a density of about 0.91 and a tensile strength ranging up to about 1,500 lb. per sq. in. as a maximum. Above a molecular weight of 60,000 the tensile strength of vistanex polymers increases rapidly. It is highly resistant to strong chemicals and ozone, and has excellent electrical properties, which make it a desirable agent for improving the properties of a great number of products made from natural rubber. It undergoes cold flow and therefore, when used by itself, shows very little or no structural strength. This is overcome by compounding with fillers and vulcanizable rubbers. When more than 50 per cent of vistanex is mixed with natural rubber, the chemical characteristics of the vistanex are predominant over those of rubber.

Vistanex is soluble in hydrocarbon solvents but is insoluble in alcohols, esters, ketones and the like. It is superior to natural rubber in respect to impermeability to gases and absorption of moisture. By a continued mechanical working or heating, vistanex can be broken down to products of lower molecular weight. It undergoes chlorination, yielding a dry, colorless, resinous product. Vistanex does not bounce at ordinary temperatures, but balls of it heated to 100° C. have rebound close to that of rubber.

Applications

Vistanex is employed to improve rubber compounds, petroleum products, hot-melt coatings, adhesives and imparts desirable properties to a vast variety of commodities, such as caulking compounds, resins, gaskets, packings and asphalts, and electrical insulations.

Low-molecular-weight grades of vistanex used in small percentages improve the viscosity index of lubricating oils; that is, the temperature viscosity relations of Mid-Continent or coastal oils can be made to approach and surpass those of Pennsylvania oils. With the use of such compositions, it is possible to devise lubricating oils which do not thicken considerably at low temperatures. These vistanex grades are also useful for compounding with paraffin wax to produce hot-melt adhesives and paper coatings which are flexible at low temperatures and more impervious to moisture than are ordinary wax coatings. This latter is largely due to the fact that the presence of vistanex inhibits the formation of wax crystals. Plastic paraffin waxes useful for a variety of articles are also made by such compounding.

Medium and high-molecular-weight grades are mixed with rubber to improve its quality, the softer types used alone being desirable for self-sealing linings of aircraft gasoline tanks.

Ozone does not cause cracking of vistanex and it has been found that compounds containing equal parts of vistanex and rubber are attacked at a very slow rate. Such compositions are desirable for insulation of wires and cables operated under high voltages. A similar mixture is also resistant to concentrated sulfuric acid and is therefore useful as acid linings. More highly resistant linings may be produced by milling the vistanex with proper fillers. Mixed with rubber, vistanex imparts added resistance to deterioration from heat and oxidation and is applicable in the manufacture of steam hose, belt coverings and other places where high temperatures are met. Such compounds may be used to manufacture inner tubes, gas masks, and balloon cloths which are less permeable to gases than natural rubber alone.

Mixed with a variety of fillers, vistanex may be used in the manufacture of gaskets, packings and caulking compounds which do not oxidize and which remain permanently flexible. Mixed with other compounds, such as asphalts and resins, vistanex imparts low temperature flexibility, added resistance to moisture, and adhesion to metals. Adhesives may be made by dissolving vistanex in aliphatic hydrocarbons, adding resins or low-molecular-weight vistanex to impart tackiness. As a plasticizer vistanex is useful for compounding with waxes and many resins, especially those of a predominately hydrocarbon character. During the present war emergency, all supplies of vistanex are under allocation and control for use in war industries.

TABLE 1—PROPERTIES OF SYNTHETIC RUBBERS

	G, gum V, vulcanized	Perbunan	Butyl	Vistanex	Buna-S
Specific gravity	G	0.96	0.91	0.91	.....
Refractive index, 25°	G	1.521	.....	1.509	.....
Tensile strength, lb./sq. in. (tread type)	V	3,500	3,200	1,500	3,200
Elongation, per cent (tread type)	V	625	800	600	650
Compression set, per cent (tread type)	V	17	25	.....	.....
Hardness, Shore	V	15-90	20-80	.....	25-90
Thermal conductivity		20% over nat. rubber	.....	.....	.....
Volume resistivity, ohm cm. at 25° C.	G	10^{16}	10^{15}	5×10^{15}	.....
Dilectric constant, 60 cycles	G	15	.....	.....	4.4
Dilectric constant, 10^3 cycles	G	.....	21	2.2	.....
Dilectric constant, 10^6 cycles		.....	.....	2.3	.....
Power factor, 60 cycles	G	10^{-4}	.....	.....	170×10^{-4}
Power factor, 10^3 cycles	G	.....	0.0004	0.0004	.....
Power factor, 10^6 cycles		.....	.....	0.0003	.....
Burning rate	G	Same as rubber	.....	.....	.....
Swelling, kerosene, vol. per cent	V	.....	Like rubber	Soluble	Like rubber
Swelling, benzol, vol. per cent	V	220	Like rubber	Soluble	Like rubber
Swelling, varsol, vol. per cent	V	20	Like rubber	Soluble	Like rubber
Swelling, acetone, vol. per cent	V	142	Insoluble	Insoluble	Insoluble
Swelling, lubricating oil, vol. per cent	V	6	Like rubber	Soluble	Like rubber
Permeability, H	G	.....	12×10^{-8}	.....	.....
Permeability, air, $cm.^3/min./cm.^2/cm.$	G	12×10^{-8}	.....	.....	24×10^{-8}
Water absorption (7 days), wt. per cent	G	3.0	2.9	2.0	.....
Resistance to strong chemicals	V	Fair	Excellent	Excellent	Fair
Resistance to ozone	V	Fair	Excellent	Excellent	Fair
Odor, taste	G	.....	None	None	.....
Heat resistance	V	Good	Excellent	.....	Good
Sunlight aging	V	Slight	Excellent	Excellent	Slight

Butyl Rubber

Butyl rubber is a copolymer of isobutylene with a small amount of a diolefin, sufficient to impart enough unsaturation to allow vulcanization; the resulting product possessing chemical stability. The product therefore has low unsaturation with an iodin number of 1 to 2 per cent of that found in natural rubber. The raw product resembles natural rubber in appearance, except that it is void of color and odor. The abundance of the raw materials in petroleum-refinery operations foretells an extensive supply of this rubber at a relatively low cost. Butyl rubber is an outgrowth of the work of Standard Oil Co. (New Jersey) with vistanex, and like vistanex is produced at very low temperatures but by entirely different methods. The molecular weight of the finished product ranges from 40,000 to 80,000 and it has a density of 0.91.

Butyl rubber as shipped in the uncured condition is already compounded with 5 parts of zinc oxide and 1½ parts of sulfur. It is by nature tacky and has a tendency to flow under its own weight and to adhere to storage racks. It does not require mastication prior to compoundings.

Physical Properties

The age resistance of vulcanized butyl rubber is excellent; it is unnecessary to add antioxidants. Normally it does not lose more than 20 per cent of its tensile strength after 2 weeks in a Geer oven at 70° C. Its electrical properties are excellent; there is no substantial loss in dielectric

TABLE 2—PLANT CONSTRUCTION SCHEDULE SYNTHETIC RUBBER AND SYNTHETIC-RUBBER RAW MATERIALS

Standard Oil Co. of New Jersey; Standard Oil Co. of Louisiana; Humble Oil & Refining Co.

Plant—	Product	Annual capacity (Long tons)	Date started	Date completed	Cumulative totals
No. 1	Butyl	7,000	6-41	12-42	7,000
No. 2	Butyl	7,000	1-42	4-43	14,000
No. 3	Butyl	7,000	1-42	4-43	21,000
No. 1 (enlarged)	Butyl	17,000	...	6-43	38,000
No. 2 (enlarged)	Butyl	17,000	...	7-43	55,000
No. 3 (enlarged)	Butyl	17,000	...	8-43	72,000
No. 4	Butyl	60,000 (Short tons)	2-42	9-43	132,000
	Butadiene	3,000	7-40	9-41	3,000
	Butadiene	6,600	7-41	1-43	9,600
	Butadiene	1,825	...	1-43	11,425
	Butadiene	15,000	7-41	4-43	26,425
	Butadiene	6,800	...	4-43	33,225
	Butadiene	30,000	2-42	3-43	63,225
	Butadiene	1,825	...	4-43	65,050
No. 1	Vistanex	1,000 (Long tons)	In operation		1,000
No. 1	Buna (S or N)	3,600	In operation		3,600

strength after soaking in water. Contrasted with rubber which is attacked by ozone, butyl rubber shows no deterioration under laboratory tests. Strong sulfuric and nitric acid leave butyl rubber intact, even after days of immersion. Salts and copper and other heavy metals are without substantial effect on the aging of butyl. Butyl rubber compounds of the tire-tread type not only have high resistance to flexing, but they lose little of this resistance after long aging. At room temperatures vulcanized butyl rubber has a low rebound and is exceptional for absorption of energy. However, at high temperatures, such as 100° C., balls of butyl rubber give approximately the same bounce as those made from natural rubber. Like natural rubber, it swells in petroleum and coal-tar solvents but not in most vegetable and animal fats. Hydrogen and nitrogen diffuse through butyl at about one-tenth the rate through natural rubber. Its water absorption is about one-fourth of that of natural rubber. These properties all result from its low saturation in the raw state and substantial lack of unsaturation after vulcanization.

Butyl rubber has a consistency equivalent to that of moderately well broken down natural rubber and is therefore ready for incorporation of pigments and other agents. The stress-strain curve, however, is different from that of natural rubber; the indicated stress rising but slightly until an elongation of 600-700 per cent is reached, after which there is quite a rapid increase in stress for small increases in elongation. Additions of carbon black increase the abrasion resistance of butyl but cause a decrease in tensile strength.

Applications

The compounding of butyl rubber is as straightforward as that of natural rubber with the exception, however, that if unsaturated aliphatic softeners, such as pine tar, factice and unsaturated fatty acids, are added (in the compounding) the resulting mixture will not cure, due to the fact that they unite with the sulfur provided for vulcanization of the rubber. Medium process oil is a suitable softener, and usually very little (5 to 10 per cent) is all that is necessary. Butyl should be cured at higher temperatures than those applicable for natural rubber with the compound increasing in tensile strength as the time of cure is lengthened. Butyl mixed with natural rubber and other synthetic rubbers do not covulcanize.

Because of the chemical inertness of butyl rubber, it is superior to natural rubber for many purposes. It has been found useful in the manufacture of long-life laboratory tubing, electrical insulation and for the manufacture of clothing and gas masks to resist chemicals and war gases. It is excellent for matting that is exposed to the action of sunlight and salt water as well as steam hose and tubing for food products. It is particularly useful for cements and spreading doughs in that petroleum naphthas may replace the toxic aromatic solvents which are employed with natural rubber.

In the manufacture of tires, butyl rubber behaves very much the same as natural rubber, requiring no changes in the tire-building equipment. Although improvements are being made, butyl-rubber tires do not perform as satisfactorily as those made from natural rubber. At the present time, butyl-rubber tires are given a life of 20,000 miles at driving speeds below 40 m.p.h.

Buna-S

Buna-S, a copolymer of butadiene and styrene was introduced in the United States along with perbunan. It is less costly than perbunan due to the fact that styrene is not as expensive as acrylonitrile. It is the major synthetic in the federal rubber program. Prior to Pearl Harbor experience indicated buna-S as the best suited for tires.

Like its companion, perbunan, buna-S is manufactured by emulsifying the raw materials, adding a catalyst to promote polymerization and coagulating to recover the final product, which is dried and milled into sheets. It is entirely hydrocarbon in its chemical makeup and is therefore subject to swelling by oils and some solvents. On the other hand it has superior aging properties; it is tough and resists heat.

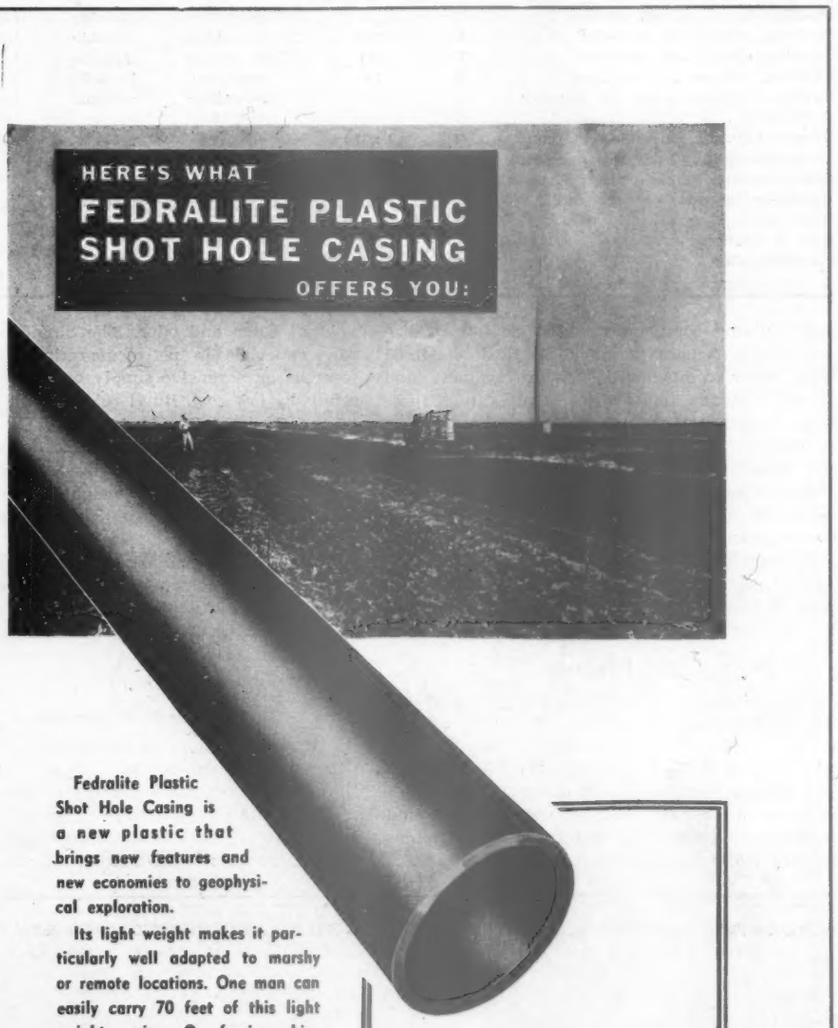
Physical Properties

Buna-S has a specific gravity of 0.94, little odor, and may vary from tan to black depending upon the inhibitors used to control its quality. It may be mixed with the same fillers employed in the processing of natural rubber in order to obtain synthetic-rubber goods possessing desired or special properties.

Relative to several other synthetics, buna-S is soft, yet it does not smooth out readily to yield good tubing and calendering properties, except with the use of loading materials. As hot milling may cause crumbling, cold milling is preferred to avoid excessive mastication. The order of compound mixing may follow that of natural rubber, and like all tough synthetics, carbon black should be added slowly in order to obtain good dispersion. Antioxidants and softeners may be used in the same proportions as in natural rubber. Channel black gives the highest reinforcement. In compounding the mill loading is the same as for natural rubber but the time for mixing is substantially longer than that for natural rubber.

Like perbunan, buna-S has lower unsaturation than natural rubber and requires less sulfur for curing. The quantity of sulfur used, however, is somewhat critical for good properties of the vulcanized compound and the quantity of carbon black employed in compounding is important in order to minimize heat buildup.

Undoubtedly buna-S will be marketed under a variety of brand names all varying somewhat



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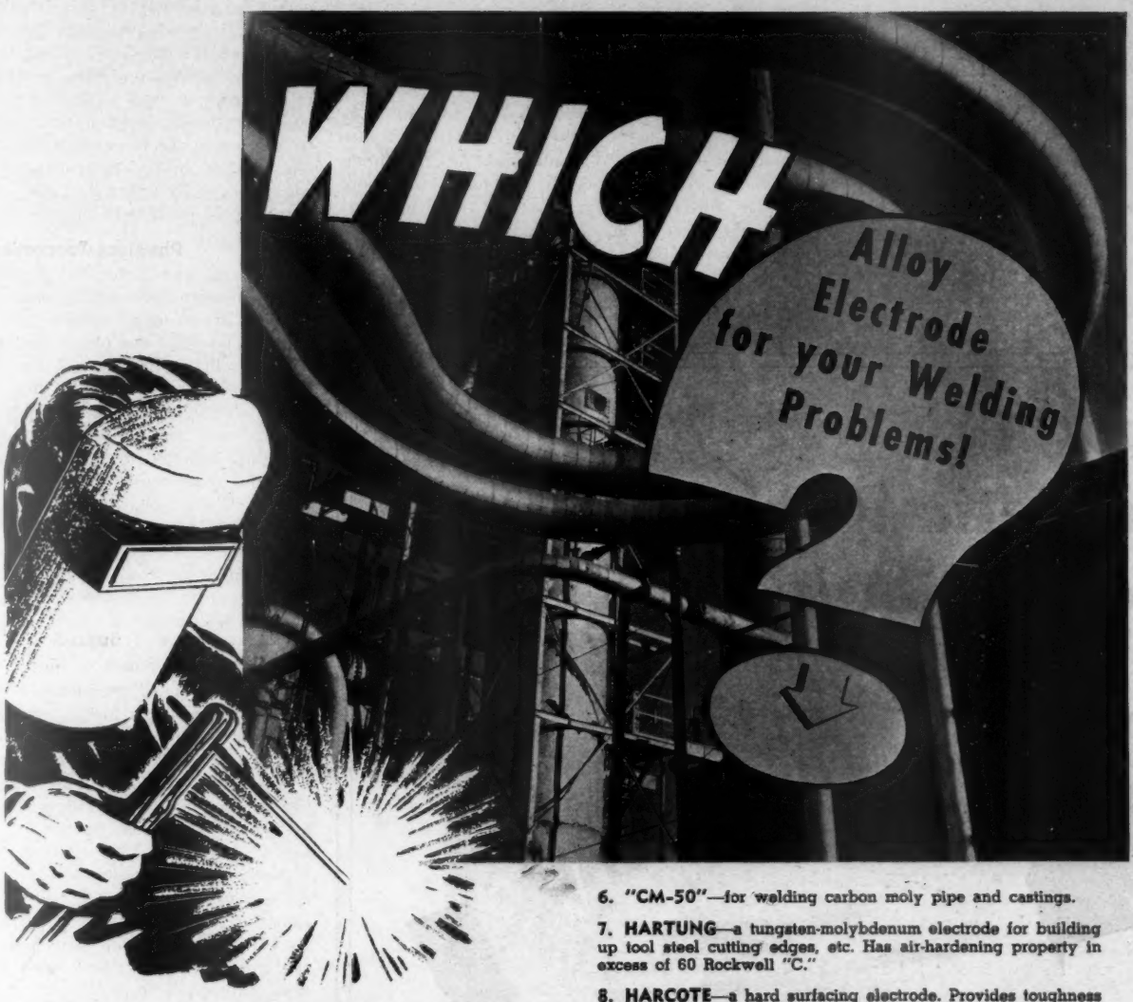

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3. **HARSTAIN 25-12**—an austenitic heat-resisting stainless electrode for 309 stainless steel and 18-8 stainless clad.

4. **HARSTAIN 25-20**—recommended for welding 18-8 stainless to mild steel plate.

5. **HARNICHROME**—for welding 4—6% chrome steel; increases resistance to corrosion and creep strength at high temperatures.

6. **"CM-50"**—for welding carbon moly pipe and castings.

7. **HARTUNG**—a tungsten-molybdenum electrode for building up tool steel cutting edges, etc. Has air-hardening property in excess of 60 Rockwell "C."

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9. **HARMOMANG**—a moly-manganese electrode. Offers great resistance to impact and abrasion.

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in specific qualities, depending upon the proportion of the raw materials butadiene and styrene used in its manufacture, as well as upon details of the process itself.

Undoubtedly the public will buy tires of buna-S and will be interested in their performance. At the present time buna-S tires wear as well as those from natural rubber. Buna-S compounds exhibit the same resistance to aging and abrasion as natural rubber and are useful to replace natural rubber in a large variety of mechanical goods. It is of value in the production of wires and cables due to its ability to stand high temperatures and rough handling. Molded goods can be made as simply as with natural rubber; battery jars, machine mountings, door seals, etc. Cements and spreading doughs may be made from it by using mixtures of aliphatic and aromatic hydrocarbons with the addition of agents to impart tack.

The continued large volume use of buna-S after the war will depend upon factors beyond present knowledge. For the present it takes the place of natural rubber better than any other single synthetic rubber.

Perbunan

Perbunan, the oil-resistant member of the buna-rubber family, and ordinarily used for special applications, was promoted in this country by the Standard Oil Co. (New Jersey). It is available in two grades, ordinary and nonstaining, as well as a grade of exceedingly high resistance to deterioration by oils and gasolines, perbunan extra. Like other specialty rubbers, it is more costly than natural rubber, but economies resulting from its use justify its existence.

Perbunan is a copolymer of butadiene and acrylonitrile and is produced by emulsifying these two raw materials in water, promoting polymerization with the use of a catalyst. At one stage in the process it occurs as a latex similar to natural rubber from which the synthetic is obtained by coagulation with acids or salts. It is then washed, dried and milled into sheets. During the process a chemical inhibitor is employed to control the quality of the finished product. The selection of this inhibitor determines whether the product becomes colored on exposure to light (ordinary) or remains colorless (nonstaining). Undoubtedly the presence of nitrogen in perbunan, as well as its low unsaturation relative to rubber, accounts for its resistance to deterioration in the presence of oils, many solvents, and to heat aging. Oil resistance increases with the nitrogen content; i.e., the concentration of acrylonitrile present in the finished product.

Physical Properties

Perbunan has a density of 0.97 and is compounded and processed in a manner similar to rubber. It is tougher and drier than natural rubber and does not plasticize by working on a rubber mill as natural rubber or buna-S does. Yet, notwithstanding this property, perbunan must be well masticated to obtain rubber compounds that can be processed easily. To this end it is best handled on a mill with the rolls kept cold and close together. Because perbunan does not break down like rubber, the use of softeners is important. Softeners of the ester type (phthalates) are most effective as well as wool grease, pine and coal tars, and factice. The sulfur content to induce good vulcanization can be lower than for natural rubber and overvulcanization offers no problems.

Carbon black has a remarkable effect in increasing the tensile strength of perbunan. The raw gum perbunan has a tensile strength only a fraction of that of natural rubber but the addition of carbon black and vulcanization raises the tensile strength of perbunan to that of good rubber compounds. Other fillers impart a high degree of reinforcement yet not to the degree given by carbon black.

Perbunan compounds are resistant to aging, high temperature, "set," and abrasion, as well as animals and vegetable fats and oils, printing inks, paints, dyes and petroleum hydrocarbons. Perbunan compounds have good flexibility at low temperatures.

Applications

Perbunan is employed in the manufacture of long-lived gasoline hose for service-station pumps and large-size hose for handling oil in and out of tankers and tank wagons. It is employed in cables as a sheath to resist oils and abrasion; for the manufacture of gaskets, seals, and diaphragms to be used in contact with oils and greases as found in pumps, oil wells, gasoline and diesel engines, measuring instruments, etc., in molded articles especially as mountings for machinery and shoe soles for use where oils are present; for printing rolls, blankets and plates. In every airplane that flies, many pounds of perbunan-type synthetic rubber are used in the construction of essential parts.

It is also useful in the manufacture of hose used in handling food products which require frequent cleaning by drastic methods. Perbunan is used in beltings of various types to improve resistance to abrasion and deterioration by heat and aging. In many of these applications perbunan shows its superiority over natural rubber in its ability to resist permanent deformation at high temperatures. Ebonite-type compounds made from perbunan excel those from natural rubber, for use in contact with hot oils and in the manufacture of brake linings. Perbunan compounds may be cured in molds, open steam, soap stone or by dry heat.

Cements and spreading doughs are made with mixtures of medium boiling ketones and aromatic hydrocarbons; alcohols or acetates mixed with aromatics are also applicable.

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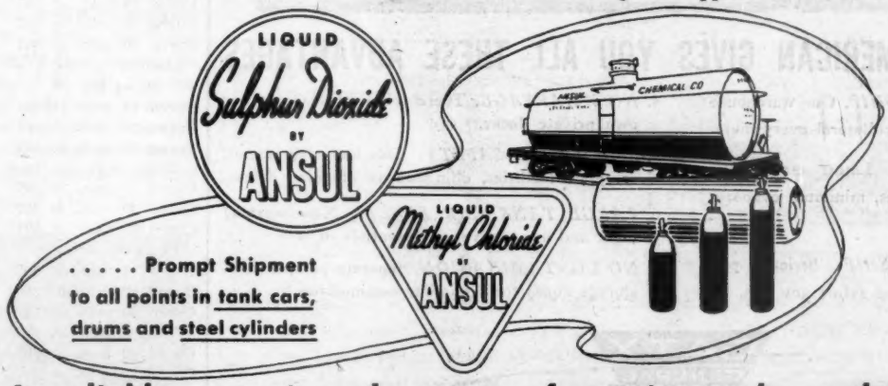

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Methods Employed in Making Synthetic Rubber

(Continued from Page 67)

of its saturated structure, cannot be vulcanized successfully, since the vulcanizer, as sulfur, adds to the unsaturated or double bonds in the reaction. Therefore, to permit vulcanization and to attain some of the more desirable properties peculiar to unsaturated polymers, small proportions of a diolefin such as butadiene are added to the isobutylene in polymerizing. The diolefin appears to act as a sort of cement or binder as well as to give a double-bond structure which can be vulcanized. As the percentage of diolefin is increased, more of the conventional rubber properties are improved with a corresponding reduction in the peculiarly desirable butyl-rubber properties such as acid resistance, heat resistance, imperviousness to gases, etc. Ultra-accelerators such as the carbamates, thiuram sulfides, and others are used in vulcanizing butyl; elasticizers such as aromatic ethers are added and a batch on the mill is "s[illegible]ed" when incorporating pigments and other accessory materials by adding to the main batch a small portion of the same material which has been heavily loaded with the additive materials, an operation which appears to improve the rate and uniformity of mixing. In general, processing butyl rubber can be carried out easily on conventional rubber-manufacturing equipment. A typical formula and the properties of the butyl rubber so compounded are shown in Table 3.

TABLE 3—COMPOUNDING FORMULA AND PROPERTIES OF BUTYL RUBBER

Formula:	
Butyl B-3 (high molecular weight)	100.0
Zinc oxide	5.0
Stearic acid	2.0
Sulfur	2.0
Kosmos 40	60.0
Benzyl ether	10.0
Tetramethylthiuram disulfide	1.0
Mercaptobenzothiazole	0.5
Williams plasticity-recovery at 158° F.	177-19
Tensile strength, in lb./sq. in.:	
Cured 15 min. at 307° F.	1,920
Cured 30 min. at 307° F.	1,650
Cured 60 min. at 307° F.	1,650
Modulus at 300% elongation, lb./sq. in.:	
Cured 15 min. at 307° F.	810
Cured 30 min. at 307° F.	1,100
Cured 60 min. at 307° F.	1,470
Elongation, per cent:	
Cured 15 min. at 307° F.	600
Cured 30 min. at 307° F.	450
Cured 60 min. at 307° F.	400
Shore hardness:	
Cured 15 min. at 307° F.	55
Cured 30 min. at 307° F.	56
Cured 60 min. at 307° F.	60
Tear resistance, lb./sq. in.:	
Cured 30 min. at 307° F.	225
Cured 60 min. at 307° F.	190
Rebound, % (cured 30-60 307° F.):	
Room temperature	47.7-50.0
212° F.	75.8-76.3
Flexometer data (cured 30-60 min. at 307° F.):*	
Shore hardness	54 56
Static compression, in.	0.414 0.364
Initial dynamic compression, in.	0.295 0.239
Dynamic drift, in.	0.074 0.031
Time of run, min.	30 30
Temperature rise, °F.	122 90
Appearance	Excellent Excellent

*Conditions of test: Load, 285 lb./sq. in.; stroke, 0.25 in.; room temperature.

Properties of Synthetic Rubber

THE utility of synthetic rubber for tires can be demonstrated only by building tires and observing their performance."

So Hayworth and Baldwin of Esso Laboratories told the American Chemical Society's Rubber Division audience last September, to summarize and epitomize the problem of developing synthetics which will supplant our natural-rubber sources and supplies, now cut off from us. And in that sentence is crystallized the principle of solution of the problem of building satisfactory synthetic-rubber tires.

In this discussion of synthetic rubbers, and in other articles in this and other issues, the broader definition of rubber is assumed. That is the definition that rubber is any material possessing the stretchability, resilience, toughness and other peculiar characteristics which are possessed by and were first developed in rubber derived from natural sources, especially from the rubber tree, Hevea Brasiliensis.

Natural Rubber Not Yet Synthesized

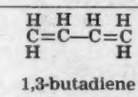
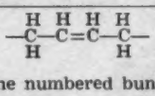
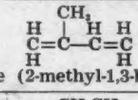
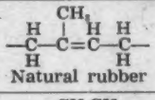
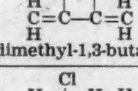
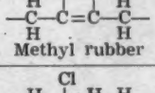
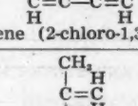
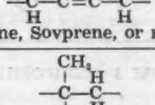
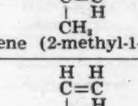
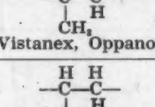
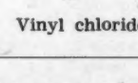
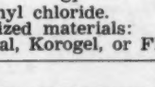
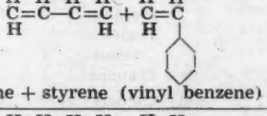
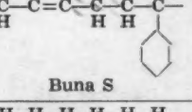
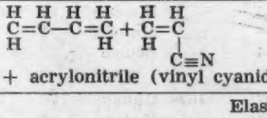
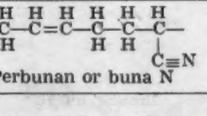
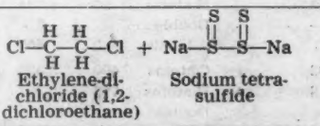
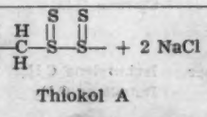
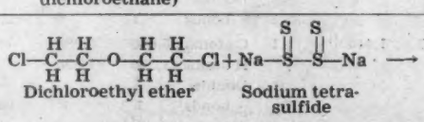
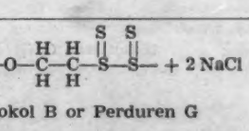
Literally, the type molecule or radical of natural rubber has been isolated and has been polymerized to a rubber-like compound, but rubber has not been synthesized actually. No synthetic rubbers now known possess the same structural formulas or composition as that of natural rubber. Closest to natural rubber in structure and unit composition are the buna numbered synthetics, composed of polymerization complexes of butadiene, $CH_2=CH-CH=CH_2$. Replacement of a hydrogen atom on carbons (2) or (3) by a methyl radical, CH_3-, gives isoprene, the unit "brick" from which the natural-rubber molecule is constructed. But no man-directed operation or reaction has reunited these units of isoprene into a rubber molecule which is identical with or possesses the identical properties which characterize natural rubber, although the latter is approximated by this method.

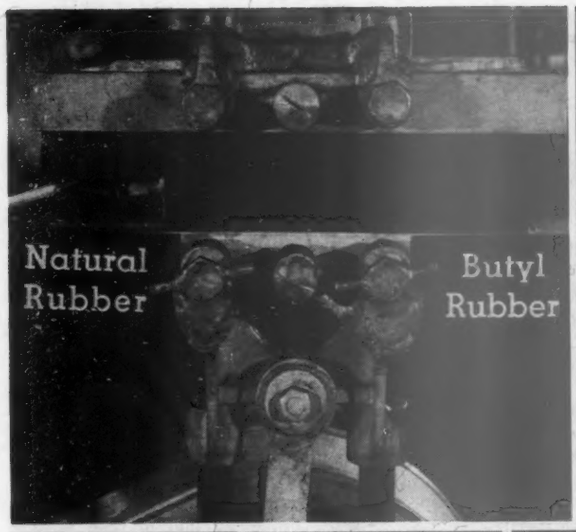
As to the synthetic rubbers which are now known and produced, their similarity to natural rubber is more that of properties than of exact identity of structure; more an identity of the manner of coupling of thousands of dissimilar units than any similarity in the structure of those units. In Table 1 is shown the type unit or units composing the more important synthetics now known. The simple polymers of butadiene such as buna 85, 115, etc., fall far short of the desirable properties of the natural product and are used only for special purposes to impart to compounded synthetics some of the properties in which these bunas excel and which are unsatisfactory in the other material used in the compounding. In (III) the type unit is identical with isoprene, the unit in natural rubber (II) with the addition of another methyl group, and is the type unit made from acetone by the Germans in 1914-18. Introduction of this methyl group imparted too much softness, too little rebound or ability to resume the original dimensions of the rubber piece when stress forces are removed; methyl rubber, as it was called, is too high in permanent set properties to be entirely practical.

In synthesizing rubber which shows good promise to replace natural rubber for many uses such as tire material, chemists have been forced to utilize copolymerization, that is, the polymerization of unlike units or radicals such as are shown in (VII) and (VIII), styrene and acrylic rubbers, respectively. Styrene rubber is typified by the buna-S product, butadiene and styrene in proportions of approximately one unit of styrene to three units of butadiene. In this polymer the

Resistance to swelling in solvents is one of the outstanding properties of synthetic rubber of the acrylic type. Here Dr. W. L. Semon, research director for Hycar Chemical Co. and discoverer of Koroseal, holds two test tires and a third which was the same size as the two tested before the beginning of the test. The two tires, synthetic (left) and natural (right) were immersed in oil at 160° F. for 2 weeks. The synthetic tire changed dimensions practically not at all, while the natural-rubber tire increased 40 per cent in diameter and 180 per cent in volume

TABLE 1—CHEMICAL STRUCTURES OF DIFFERENT SYNTHETIC RUBBERS

	Monomer	Unit of polymer
	Simple polymers	
(I)	 1,3-butadiene	 The numbered bunas
(II)	 Isoprene (2-methyl-1,3-butadiene)	 Natural rubber
(III)	 2,3-dimethyl-1,3-butadiene	 Methyl rubber
(IV)	 Chloroprene (2-chloro-1,3-butadiene)	 Neoprene, Sovprene, or mustone
(V)	 Isobutene (2-methyl-1-propene)	 Vistanex, Oppanol
(VI)	 Vinyl chloride	 Polyvinyl chloride. Plasticized materials: Kerosseal, Korogel, or Flamenol
	Copolymers	
(VII)	 Butadiene + styrene (vinyl benzene)	 Buna S
(VIII)	 Butadiene + acrylonitrile (vinyl cyanide)	 Perbunan or buna N
	Elastothiomers	
(IX)	 Ethylene-di-chloride (1,2-dichloroethane); Sodium tetra-sulfide	 Thiokol A
(X)	 Dichloroethyl ether; Sodium tetra-sulfide	 Thiokol B or Perduren G



Top, left: The results of flexing tests shown here illustrate the superiority of butyl rubber in this property over natural rubber, the latter shown at left, after being flexed (bent) under identical conditions several hundred thousand times in the test machine. This test simulates the action of road service on the side wall of a tire as it repeatedly supports the car weight and is flexed while running

Top, right: By testing a tire (an airplane balloon here) on a large rotating wheel under pressures and temperatures approximating those undergone in service the comparative life of the tire in actual service may be predicted

Bottom, left: Another means for determining the relative properties of a tire is with this puncture machine, which does for the tire what a sharp stick or stone does in service. From the results obtained on these tests the value of the rubber for tire making is determined

Bottom, right: Extrusion properties of a rubber, especially for tubing, coatings insulation, and similar purposes, may be determined by actual extrusion of the rubber in this laboratory machine

pendant phenyl radical, C_6H_5–, is totally foreign to natural rubber, so far as the chemist can discover. To the presence of this radical, and the absence from butadiene of the single methyl group which is present in isoprene doubtless can be traced the origin of the differences in properties and behavior of the two products, styrene and natural rubbers.

In acrylic rubber, typified by the buna N, (Perbunan), Hycar OR and similar products, the molecular structure and composition are still further afield (VIII). The main chain unit composing this polymer is somewhat similar to those in both natural and styrene rubbers, but like the latter has a pendant group, the cyanogen radical, —C≡N, attached to the main chain and introducing a third element, nitrogen, into the molecule. To the variation in the proportion of carbon and hydrogen and to the presence of this nitrogen atom in the unit may be traced the differences between this type of rubber and natural, and its peculiar properties such as resistance to solvents, oxidation, etc.

Varying in the nature and proportions of other and minor ingredients, in methods of processing and finishing, all our present types of tire rubber and part of our specialty rubbers which are expected to relieve our shortage of natural rubber are composed of these three essential units with butadiene as the common ingredient. In addition to these types are, for example, neoprene, composed of a butadiene unit in which a hydrogen of carbon atom (2) is replaced by a chlorine atom to form chloroprene, the simple polymerization of which forms the neoprene (formerly called duprene) of America, the sovprene of Russia and the mustone of Japan.

Isobutene when polymerized only with itself becomes the vistanex of America or the oppanol of Germany, a highly viscous, resinous material employed for certain nonrubber purposes such as in improvement of viscosity index in lubricating oils, etc. When polymerized with 2 to 3 per

TABLE 2—COMPOSITION AND STRUCTURE OF NATURAL AND SYNTHETIC RUBBER

Product—	Raw material (monomers)	Mol. wt.	Gross character (approx.) Mol. wt.	No. of original molecules	Repeating units/ mol.	Detail character—structural elements: Per repeating unit		Per molecule	Double bonds/1,000: Carbon atoms	Total atoms
Rubber	Isoprene C_5H_8	68	150,000	2,210	2,210	C atoms	5	11,050		
						H atoms	8	17,650		
						Double bonds	1	2,210	2,000	770
Neoprene	Chloroprene C_4H_5Cl	88	100,000	1,135	1,135	C atoms	4	4,540		
						H atoms	5	5,680		
						Double bonds	1	1,135	2,500	1,000
						Cl atoms	1	1,135		
Buna-N	Butadiene C_4H_6	54	100,000	1,391	463	C atoms	15	6,950		
	Acrylonitrile C_3H_3N	53		463		H atoms	21	9,720		
						N atoms	1	463		
				1,854		Double bonds	3	1,391	2,000	812
Buna-S	Butadiene C_4H_6	54	45,000	507	169	C atoms	20	3,380		
	Styrene C_8H_8	104		169		H atoms	26	4,394		
						Double bonds	3	507	1,500	652
				676						
Butyl-rubber	Isobutylene C_4H_8	56		702		C atoms	400	3,200		
	Butadiene C_4H_6	54	45,000	8	8	H atoms	798	6,332		
						Double bonds	1	8	25	8.3
Vistanex	Isobutylene C_4H_8	58	80,000	1,440	1	C atoms	5,660	5,660		
						H atoms	11,320	11,320		
						Double bonds	1	1	1.8	0.6

TABLE 3—COMPARISON OF RELATIVE PROPERTIES OF NATURAL AND OF SEVERAL SYNTHETIC RUBBERS AND ELASTOMERS

Property—	Rubber	Neoprene	Thiokol	Koroseal	Perbunan	Oil resistant Ameripol
Abrasion and tear resistance	E	G	P	E—if heat is not generated	E	E
Adhesion to metals	E	E	F	F	E	E
Aging in storage	E	E	E	E	E	E
Chemical resistance:						
Oxidizing solutions	P	P	P	E	P	P
Ozone	P	E	E	E	F	F
Solutions of salts, alkalies and acids	G	G	G	G	G	G
Color range	E	G	P	E	F	G
Resistance to cutting	G	G	P	E	G	G
Resistance to diffusion of gases	F	G	E	E	G	G
Elasticity and rebound	E	G	P	F	G	F
Electrical properties:						
Conductivity	F	F	F	F	F	F
Resistance to corona cracking	P	E	E	E	P	P
Dielectric strength	E	F	F	E	F	F
Flame resistance	P	G	P	E	P	P
Resistance to flexcracking	G	G	F	E	G	G
Resistance to flow:						
Cold	E	G	P	F	E	E
Hot	E	F	P	P	E	E
Hardness range—Durometer A	20-100	10-90	20-80	10-100	10-100	10-100
Low heat generation through hysteresis	E	F	F	..	F	F
Freedom from odor	G	F	P	E	F	F
Resistance to swelling in:						
Chlorinated or aromatic solvents	P	P	G	Shrinks because of extraction of plasticizer	P	F
Lacquer solvents	P	P	G		P	F
Mineral oil or gasoline	P	G	E		G to E	E
Water	F	G	..	E	E	E
Resistance to deterioration by mineral oil	P	E	F	G	E	E
Specific gravity of basic material	0.93	1.25	1.35	Ave. plasticizer content 1.30	0.98	1.00
Range of stretchability	E	G	F	F	G	G
Resistance to checking in sunlight	F	E	E	E	F	G
Stability of properties with change of temperature:						
Cold	E	F	E	F	G	G
Heat	G	E	P	P	E	E

E—excellent. G—good. F—fair. P—poor.

cent of butadiene it forms butyl rubber, an inert, highly saturated rubber-like material, extremely useful where chemical inertness is of paramount importance, and now planned as an ersatz material to eke out our tire rubber supply during the emergency, until the more serviceable tire rubber made from butadiene and styrene is in full production.

The remaining products shown in Table 1, polyvinyl chloride and the elastothiomers thiokol A, B, and several other varieties, are less closely allied to rubber in composition and properties and may be classed generally as plastics which under given treatments develop some of the properties of rubber which are highly specialized and more useful for certain special applications of rubber than is rubber itself, either synthetic or natural. Details of composition and structure of several synthetics are given in Table 2.

As to the actual structural configuration of rubbers no definite information is available, although several theories have been advanced which explain more or less satisfactorily many of the properties of rubber. Most authorities consider that the rubber molecule is made up by linear junction of several thousand units such as those mentioned above, arranged in more or less regular order of succession of different units in the case of copolymer rubbers, with double bonds regularly spaced according to a definite plan. This formation is called a straight-chain arrangement, but does not necessarily mean a straight line of successive atoms; more likely it means a highly complex and interlaced line or "rope" involving three-dimensional latices. The theory of crosslinkages attempts to explain some rubber properties, and in that theory it seems most logical that one double-bond linkage between carbon atoms is brought into closer space relationship with another double bond, and that one or both pairs of double bonds are broken to reunite in linking nonadjacent carbon atoms. This constitutes a "brace" or link across the molecule, and doubtless explains in part at least resilience, tensile strength and elongation properties of rubber. One theory regards the rubber molecule as a system of levers or of individually interconnected straps or bars with rigid junctions but flexibility within the individual strap and therefore within the molecule as a whole and in relation to adjacent molecules. Stress produces compression or extension, "bending" the bars and the molecules from their normal unstressed shape but retaining a springiness which when the stress is removed returns the molecules to their original form. Just as a spring can be permanently distorted and will not return entirely to its original shape when its elastic limit is exceeded, so rubber exhibits hysteresis and takes on a "permanent set" when distended or compressed too far or for too long a period. Rubber ages by oxidation and exposure to weather conditions, solvents, heat, etc., losing its springiness just as a metal spring loses its ability to resume its original form and position when a stress which distorts it is removed.

X-Ray Patterns

Study of X-ray patterns made by natural and synthetic rubber have thrown some interesting light on rubber structure without in any final

TABLE 4—COMPARISON OF RUBBER STOCKS

Base material—	Temp. of blowhole formation—Gum stock— No.	°C.	Tread stock— No.	°C.
Buna-S	DD	254	MM	233
Butaprene NM	EE	248	NN	244
Butaprene NXM	FF	248	OO	233
Neoprene GN	GG	227	PP	233
Smoked sheet	HH	198	QQ	198
Whole tire reclaim	II	146	RR	157
Black tube reclaim	JJ	159	SS	157
Untreated guayule	KK	143	TT	138
Deresinated guayule	LL	150	UU	153

TABLE 5—EFFECT OF CURE ON TYPICAL TREAD STOCKS

Curing time at 143.3° C., min.	Temp. of blowhole formation, °C.— Hevea rubber (QQ)	Buna-S (MM)	Deresinated guayule (UU)
25	187	187	155
45	197	228	155
65	202	232	155
85	...	232	155
105	...	...	155
125	...	...	155

TABLE 6—RESISTANCE OF BUTYL RUBBER TO ACIDS

Acid—	Concentration, %	Time, weeks	Butyl B-1.45 Tensile lb./sq. in.	Butyl B-1.45 Elongation, %	Butyl B-3 Tensile lb./sq. in.	Butyl B-3 Elongation, %	Natural Rubber Tensile lb./sq. in.	Natural Rubber Elongation, %
None (original rubber)			2,500	950	2,400	970	3,790	790
Immersion temperature, 100° F.								
Sulfuric	70	One	2,730	960	1,980	930	255	230
	70	Two	1,480	930	1,920	920	165	170
	95.5	One	2,490	960	(*)	(*)	Decomposed	
	95.5	Two	2,700	910	(*)	(*)	Decomposed	
Nitric	35	One	1,590	990	1,690	940	810	600
	35	Two	Soft, tacky		Soft, tacky		Decomposed	
	70	One	Decomposed		Decomposed		Decomposed	
	70	Two	Decomposed		Decomposed		Decomposed	
Hydrochloric	37	One	2,170	930	2,080	1,010	3,390	700
	37	Two	1,450	1,010	840	950	3,070	650
Immersion temperature, 140° F.								
Sulfuric	70	One	2,850	950	2,500	940	140	10
	70	Two	2,460	930	1,970	940	Brittle	
	95.5	One	2,690	940	525	850	Decomposed	
	95.5	Two	2,390	910	(*)	(*)	Decomposed	
Nitric	35	One	Decomposed		Decomposed		Decomposed	
	35	Two	Decomposed		Decomposed		Decomposed	
	70	One	Decomposed		Decomposed		Decomposed	
	70	Two	Decomposed		Decomposed		Decomposed	
Hydrochloric	37	One	1,180	950	1,100	940	1,460	70
	37	Two	790	920	780	930	1,860	20

*Complete cleavage.

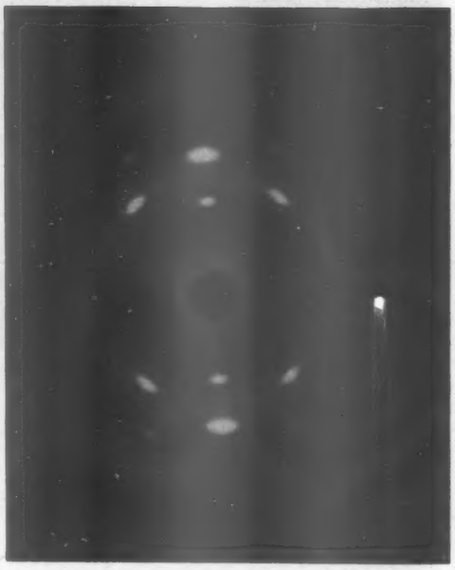
sense answering the question of molecular form and interlinkage. Observing the accompanying photos (Figs. 1 to 5) natural rubber when unstretched exhibits a ring-type of lighted figure which the X-ray expert calls a "broad halo," without outstanding brighter spots which are caused by fiber structures. When stretched, there appears a recurrent series of bright spots accompanied by a decided dimming of the halo. Similarly, synthetic rubber polymers in some cases show a large or a small number of such spots when the material is stretched, whereas others which are essentially copolymers show no appreciable change in the light halo except probably a dimming effect. Under certain conditions rubber gives no such spots when stretched, such as when raw rubber is heavily milled. Frozen rubber when unstretched gives a series of rings such as are formed by a crystal powder.

Scientists believe that stretching forms rubber into a type of crystal structure or orients particles in long lines parallel to the direction of stretch. Unsaturation appears not to have any part in this crystal structure under stretched condition, as polyisobutene (vistanex) shows a fiber pattern while some thiokols do and some do not. Thiokol is unsaturated while vistanex is saturated. Whether or not rubber molecular structure will ever be wholly understood is conjectural.

Of far more immediate importance are the properties of synthetic rubbers from a practical industrial and commercial viewpoint. These properties are measurable if not always predictable from fundamental or theoretical bases. And because we know the properties and limitations of natural rubber so well in comparative terms, and what those properties permit us to do with natural rubber in the manufacture and use of rubber articles synthetic rubbers are inevitably compared with natural to determine properties of superior and of inferior values.

In general, natural rubber is superior to synthetic in the important properties of tensile strength, stretchability or elongation, resilience or speed of "comeback," and in resistance to permanent set, that is, loss of power to resume original dimensions after removal of stresses. Synthetic rubber is distinctly superior to natural in aging resistance, resistance to abrasion—important as wear, especially in tires—to sunlight and photochemical effects, to the effects of solvents of all types as oils, fuels, hydrocarbon and compound solvents, to coronal discharge—which produces ozone, inveterate enemy of natural rubber—and to diffusion of gases.

In reality we obtain a better comparative picture of synthetic rubber and its position with regard to natural rubber if we compare our present synthetic products with the natural rubber of the turn of the century. At that time the technology of natural rubber was in somewhat the same age of development as is synthetic rubber



Figs. 1 and 2—X-ray diffraction patterns for natural and synthetic rubbers in stretched and unstretched condition, show differences in structure not yet fully explained. Fig. 1 (top), shows natural rubber in normal or unstretched condition; Fig. 2 (bottom), the same rubber stretched, showing the "fiber spots" of a crystalline structure

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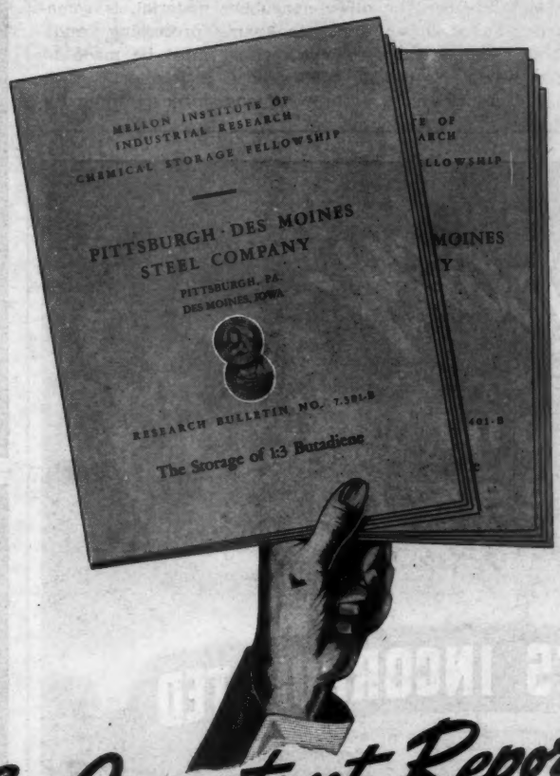

Two Important Reports

ON { THE STORAGE OF 1:3 BUTADIENE
THE STORAGE OF ISOBUTYLENE

New facts developed by new research, comprehensively presented for use in the synthetic rubber industry. Prepared by the Pittsburgh-Des Moines Chemical Storage Fellowship at Mellon Institute of Industrial Research, these publications may be obtained by requesting P·DM Research Reports No. 7.381-B (Butadiene) and No. 7.401-B (Isobutylene). The quantities are limited.

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now. Our present natural rubber is the result of hundreds of thousands of experiments to improve its properties, while synthetic-rubber technology is still in swaddling clothes. To consider that our present synthetics represent the last word in their development is the equivalent of freezing the rubber of 1900 as being the ne plus ultra in that older field, a statement which immediately becomes ridiculous. It appears safe to predict that the synthetic rubber of 1960 will be as superior to our present synthetics as the natural rubber of 1942 is superior to that of 1900.

No synthetic rubber has been developed as yet which in all properties is equal or superior to natural rubber as modern technology has develeloped the latter. When it is remembered, however, that the tread life of natural has been extended from 3,000 miles at 15-25 m.p.h. speeds to 15,000-30,000 miles at 50-70 m.p.h., between about 1900 and 1940, it is obvious that our present excellence of synthetic rubber should be improved qualitatively in an analogous way during the next decade or two.

Synthetic rubber is more nearly saturated than is natural, and therefore exhibits greater hardness in the crude material than does natural rubber. It is thus harder to mill or break down its physical structure during processing. Synthetic rubber is not so resilient as natural, its rebound is lower, its resistance to permanent set is lower. Its binding property, ability to weld itself to fabric, cord or other nonrubber material, is somewhat lower under the same processing conditions; therefore, extra effort must be made to make synthetic rubber bond satisfactorily with fabrics used with it for any purpose, and with cord in tire fabrication. Comparisons of natural and synthetic rubber's various properties are shown in Table 3.

Synthetic-rubber treads, however, are superior in wear life to natural-rubber treads. This is due in part to its greater degree of saturation and thus its greater resistance to oxidation—aging—and to its inherently greater internal tenacity.

Figs. 3 and 4—Butyl rubber, unstretched: (top) shows the familiar halo of noncrystalline structure; stretched (bottom), it also shows the "fiber spots" similar to natural rubber

Some varieties of synthetic tire rubber exhibit an appreciably greater ability to resist skidding on wet pavement, a property which rubber technologists are studying especially, to improve this danger-reducing property. Superior aging qualities also postpone formation of age cracks—weather cracks— in tires, thus delaying the speed with which water and other solvent liquids enter the tire carcass to continue the disintegration process.

One drawback to the advantageous utilization of the built-in properties of synthetic rubber is its greater heat development during flexing such as in tire service. The strength of rubber is generally a function of the temperature of operation, the higher the temperature the shorter the service life. Synthetic rubber develops greater heat—higher tire temperatures—than does natural rubber under identical conditions. Under these conditions and other conditions being equal the shortening of tire life will be greater the

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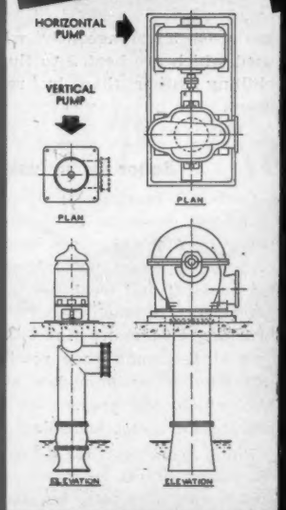
SAVE SPACE ON LOCATION: Check over your Pomona installation. It may be that it was simply set into the area occupied by your former pump with little thought given to maximum space utilization. Can you move your Pomona to an out-of-the-way corner—or into a space too small for other equipment—and thus gain added floor space for new equipment?

USE TOP-OF-TANK SPACE NOW WASTED: If your Pomona is not now located over the sump or tank from which it pumps, why not put it there? This space is generally wasted with other-type pumps because of their excessive weight and the difficulty of setting rigid foundations over a sump. But Pomonas need no heavy foundations—in fact, just two timbers anchored across the top of the sump is usually sufficient support for these compact self-balanced pumps. So by relocating your Pomonas over the sump or tank, you can gain solid floor space for other heavy-duty purposes.

ELIMINATE SPACE-WASTING PIPING: Another important way you can save space with Pomonas is by running all piping either below floor level or overhead, thus leaving the floor space open. You can do this with Pomonas far more easily than with other types because their positive-lift characteristics eliminate need for a fixed level discharge in relation to pump position.

UTILIZE REMOTE LOCATIONS: Still another important space-saving feature of Pomonas is that the impellers are at water level and require no priming to start. This not only eliminates space-consuming priming equipment but—even more important—enables you to place Pomonas at remote out-of-the-way locations and operate them automatically with only infrequent attention. That leaves more floor space free in the center of the plant for equipment that requires the operator's constant attention.



higher the temperature at which the tire operates and synthetic rubber is at a disadvantage in comparison to the superiority it displays when tested at uniform temperatures. One of the major problems of the synthetic-rubber compounder is to reduce or eliminate this inherent disadvantage, to give synthetics their advantage of inherent greater wear characteristics.

Synthetic Rubber's Superiorities

This disadvantage does not appear to a measurable extent in light and medium-duty service such as high-speed passenger-car tires, and such tires have been made which give quite as long service on passenger cars as typical first-grade natural-rubber tires. In heavy-duty service such as trucks, buses, etc., tire temperature rises to 225° F. and even higher, and operation of tires under these conditions is equivalent to rapidly recurrent flexing under extremely heavy loads while immersed in a bath of continuously boiling water. When synthetic tires are employed their service life is further reduced since this rubber (buna-S type) loses tensile strength and internal tenacity faster with higher temperatures.

Synthetic rubber's greater impermeability to passage of gases through the rubber mass gives a distinct advantage in innertube making, provided other properties are satisfactory for the purpose. Unpublished information indicates that whereas natural-rubber tubes may require pumping up every month the synthetic product will hold sufficiently well to require additional air at only half as frequent intervals. Butyl rubber, because of its density and inertness, appears to be especially advantageous for this purpose, but more especially so for industrial tubing for the conveyance of light hydrocarbon gases and vapors, hydrogen, helium and low molecular weight gases which pass relatively rapidly through the natural product. Isoprene, Hycar OR, one or two of the types of Chemigum and Koroseal and Thiokol possess this gas impermeability property in varying degrees, but in general considerably higher than natural rubber.

In the acrylic type of synthetics, resistance to swelling and disintegration in solvents is their outstanding feature of superiority. So, for hose and liquid conveyors of practically every kind this type of synthetic is vastly superior to any natural-rubber compound now known. This includes water, steam, gasoline, lubricating oils, fatty animal and vegetable oils, aromatic oils and similar materials. Witness to this advantage is the use of neoprene for gasoline hose, thiokol for gaskets, etc. Newsprint-press inking rollers made of the Hycar OR or buna-S type of rubber last much longer in service than do the older glue-glycerin rollers so long used, except where inks containing manganese or cobalt driers are used. Because of heat resistance synthetic-rubber rolls

Fig. 5—Differing from natural and butyl rubbers, synthetic rubber (Chemigum here) shows no "fiber pattern" either stretched or unstretched. In some cases stretching causes a dimming of the halo as compared to that seen in the unstretched rubber (Photos courtesy Goodyear Tire & Rubber Co.)

are used advantageously where solid inks are used which are heated to fluidity and harden by chilling rather than by rapid oxidation with driers. The new paper, PM, is said to be printed on this type of system.

Better for Industrial Uses

Outboard bearings of propellers on boats and ships are generally of rubber lubricated by the water in which they are immersed in service. In oil-polluted water natural-rubber bearings swell, become soft and weakened and require early replacement. In such service oil-resistant rubber bearings give many times the length of service and at the same time retain the advantage of distortion to accommodate silt and abrasive solids, which are present in the water, without scoring the metal journals.

Pump packings are subjected to very severe conditions of oil, water, steam, superheat, abrasive suspensoids, etc. In one hydraulic-pump installation an oil-resistant synthetic-rubber packing gave a life of 1,140 hours, whereas the best natural-rubber product had lasted only 240 hours or about one-fifth as long. A combination lignin-neoprene gasket has withstood 650° F. for indefinite periods, so is used in various types of seals, etc.

(Continued on Page 105)

A TRIBUTE
to
CITIES SERVICE
from
57,000 FEET
UNDERGROUND

Read these testimonials from a famous drilling company — the italics are ours — the satisfaction is our customer's.

Drilling equipment is both expensive and sensitive. Therefore, lubrication is a particularly important item in its care. Thus, it is with particular pride that we offer the following endorsements from the Schoenfeld-Hunter-Kitch Drilling Company, of Oklahoma City, who have long used Cities Service Diesel Oils.

1. We are pleased to report we have drilled over 57,000 feet of wells using Cities Service Diesel Oils. *We have experienced no ring or bearing trouble* in our motors and at the present time the engines are in excellent condition.

2. Your diesel oils give us such satisfactory service we decided to add filters to our D-17,000 Caterpillar Drilling Units and use diesel oil in them. Again we are glad to say that we have *60,000 feet* of wells behind these units without lost time due to lubrication.

3. We changed oils in these diesel units approximately every 125 hours before trying Cities Service Diesel Oil. We now change oil every thousand hours but with only two gallons of make-up oil per day for the two motors.

Cities Service diesel lubricants are service proved. They have been tested — proved by years of service to be lubricants that give outstanding resistance to wear. Cities Service lubrication engineers have a wealth of experience in prescribing and checking results in the diesel lubrication field. You can draw on this background of experience to answer your lubrication problem. Consultation of the Lubrication Engineers Service is absolutely free.

CITIES SERVICE OIL COMPANIES

CITIES SERVICE OIL COMPANY—New York, Boston, Chicago, St. Paul, Cedar Rapids, Grand Forks, Kansas City, Fort Worth, Oklahoma City, Milwaukee, Cleveland, Detroit.

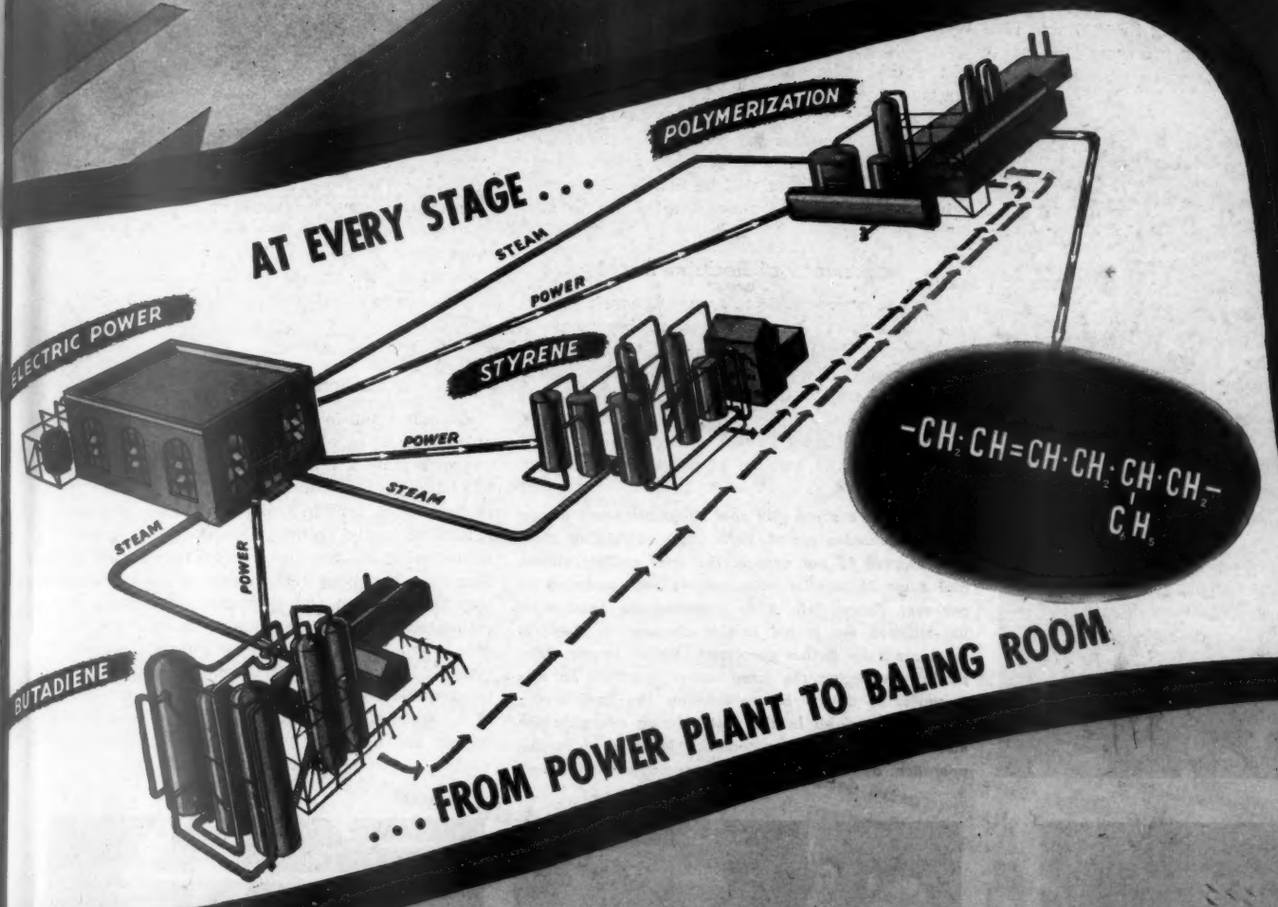
CITIES SERVICE OIL COMPANY, LTD.—Toronto, Ontario.

ARKANSAS FUEL OIL COMPANY—Shreveport, Little Rock, Jackson, Miss., Birmingham, Atlanta, Charlotte, N. C., Nashville, Richmond, Miami.

CITIES SERVICE OILS
ONCE-ALWAYS

Electrical

for the Synthesis of Rubber



It's a Tremendous Program . . . and We Can Help

SYNTHETIC rubber presents the most challenging problem that has ever been placed in the lap of American industry. Never before in its history has our nation been called upon to conceive and bring to maturity such a big, new industry overnight.

Such a task demands teamwork. Just the chemical and processing problems of making the basic raw materials for synthetic rubber call for all the ingenuity and skill of the engineers of America.

Let *us*, therefore, take from your shoulders the equally vital problems of providing quickly the completely co-ordinated electrical system that must be planned, purchased, and installed in record time. ***General Electric, Schenectady, N. Y.***

The Navy "E", for Excellence, has been awarded to 92,700 General Electric employees in six plants manufacturing naval equipment

Role of Reclaimed Rubber In Rubber Technology

RECLAMATION of rubber, per se, has no direct part in the development of an American synthetic-rubber industry, but because of the effect of reclaimed rubber on our available supply under the present emergency the subject will be included briefly here to show some of its part in the picture.

According to Joseph E. Pogue (speaking before the Interstate Oil Compact Commission, Lexington, Ky., June 20, 1942), about 27 per cent of the 4,794,000 tons of crude rubber used in the United States during the decade ending in 1940 was returned to use by reclaiming processes. In 1941, 256,000 long tons of rubber was reclaimed, or 32 per cent of the total production during that year. When we consider that, in discarding a worn tire, only about one-sixth of the rubber it originally contained has been actually dispersed and destroyed beyond recall, it becomes obvious that the reclamation of this scrap is or may be an important factor in extending our rubber supply to meet our emergency needs of the moment, until our synthetic-rubber industry may be placed in full-scale operation. With an over-all consumption (in making tires 70 per cent of this total was used in the past) of 800,000 long tons these ratios show 460,000 tons of rubber still remaining in the used tires, theoretically available for reclamation. If even one-third of this total is recovered, we have about 155,000 tons to add to our total supply. Doubtless, under the impetus of wartime enthusiasm and extraordinary efforts to collect scrap this amount will be increased to something of the order of a quarter million tons or more, in 1942.

Importance of Reclaim Supply

It appears reasonable to assume, therefore, that one-fourth of our total available rubber demands in 1943 may be met by reclaimed rubber. Since it will require a much smaller proportion of our needs than this to mean the difference between adequacy and suicidal shortage of rubber, it may be seen that at least in this emergency reclaimed rubber holds the balance of power to determine whether we shall have enough rubber to maintain our national existence or whether we shall lose this war because of that small percentage which may represent the balance between success and failure. Reclamation of rubber is thus a critical factor, especially in the prosecution of the war.

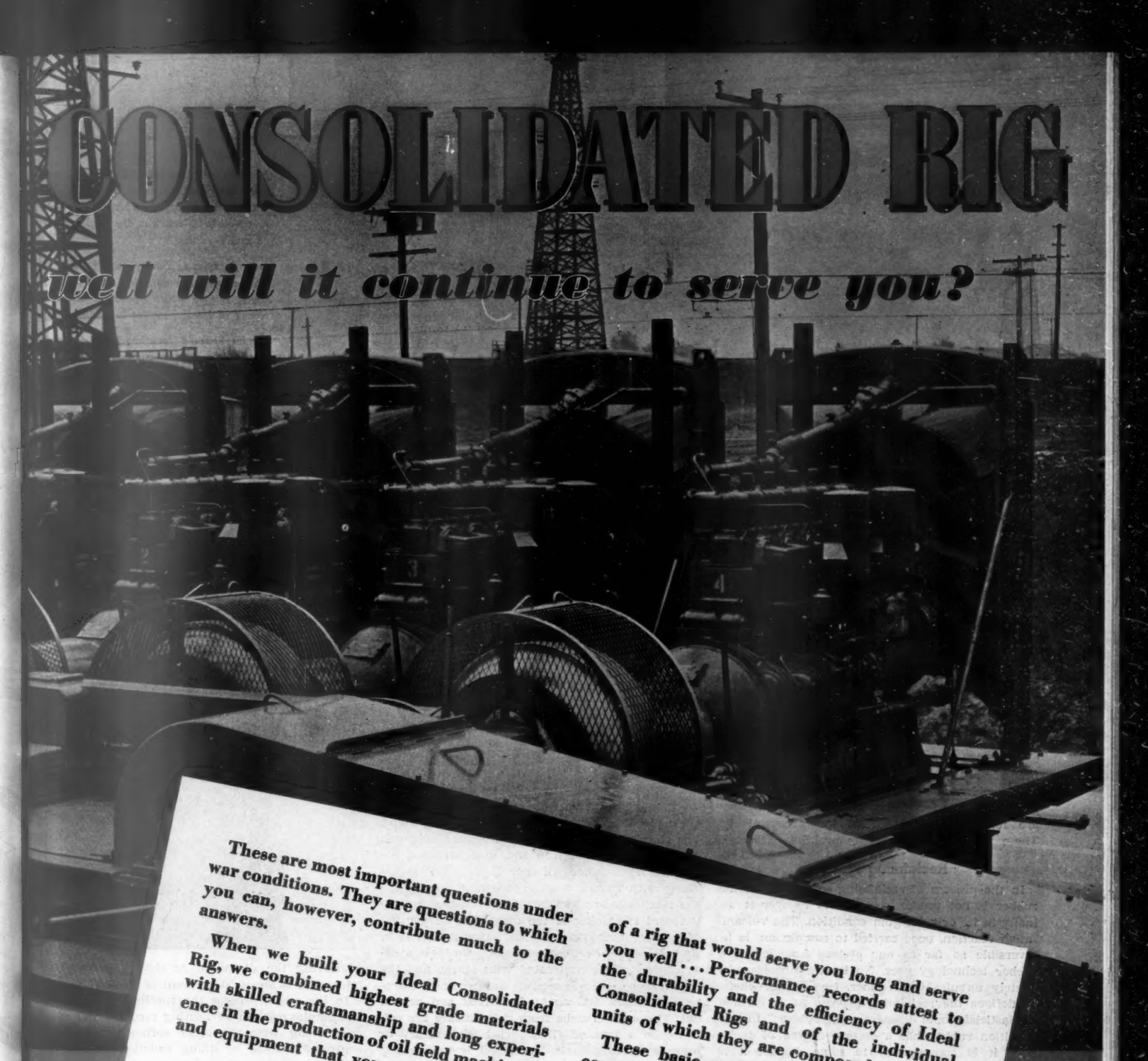
While the amount of reclaimed rubber employed in tires for war vehicles is negligible, maintenance of motor transportation behind the front, in our national operations in providing for wartime industrial, commercial, and civilian needs which become absolute necessities if the prosecution of the war is not to be hamstrung, dictates the maximum utilization of this material for these latter purposes. Already a war-emergency tire made almost entirely of reclaimed rubber (it contains 4 oz. of crude rubber) is being manufactured for those less-severe services at present regulated low driving speeds, which will give 10,000 miles or more of service at 35 m.p.h. maximum speed. These tires alone can keep the civilian population, or a major portion of it, in position to do its essential driving and thus to maintain a good part of our civilian living on a bearably endurable level.

Million Tons Available

Estimates and inventories of scrap rubber available on hand as of the middle of 1942 show that approximately a million tons of such material is available but not collected, found here and there in junk piles, around homes and industrial establishments in the country. Much of this quantity, estimated at 450,000 tons, has been collected since that time and is at reclamation centers or on its way there. From the tires now in service it is estimated that 1,200,000 tons of rubber are available when those tires can no longer be used. A total of 450,000 tons of scrap is available from used-rubber sources other than tires, giving a total of 2,100,000 tons of scrap which may be collected during the next 1½ years. The potentialities of

(Continued on Page 98)

(Left) Part of a scrap pile now being processed at one of our reclaiming plants. Eight large reclaiming units now process 85 per cent of the total reclaim output, and some 25 smaller units recover the remaining 15 per cent. Below, left: After removing the bead wire, the stripped tire is fed to this chopper or "hog" to macerate it for further processing. Below, center: After partial dewatering, the scrap rubber is passed hot into a squeezing device before entering the final drying step. Below, right: In the first refining operation the major portion of foreign material is removed in this operation, and the reclaim is recovered in rough sheets



These are most important questions under war conditions. They are questions to which you can, however, contribute much to the answers.

When we built your Ideal Consolidated Rig, we combined highest grade materials with skilled craftsmanship and long experience in the production of oil field machinery and equipment that you could be assured of a rig that would serve you long and serve you well . . . Performance records attest to the durability and the efficiency of Ideal Consolidated Rigs and of the individual units of which they are composed.

These basic and intrinsic values will, if conserved, keep your rig operating efficiently and economically beyond the customary expectancy of service.

We Recommend the Following Maintenance Schedule:

DRAW WORKS AND DRIVE GROUP:

1. Maintain adjustments of all friction clutches and replace worn out parts that impair efficient operation.
2. Keep all roller bearings properly lubricated.
3. Make frequent inspection of all positive clutches and shifter mechanisms.
4. Check air control equipment for leaks—connections, lines, valves and compressor unit.
5. Chain and V-belt drives should be systematically inspected for correct tension and alignment. Proper lubrication prolongs chain life.

ENGINES:

1. Avoid continuous overloading. It may become necessary to change to smaller pump liners as the well gets deeper.
2. Change crankcase oil at regular specified intervals and use only high quality lubricants.
3. Keep all filters clean.
4. Inspect engines frequently to detect worn or stuck piston rings, valve wear and clearances, and correct immediately.
5. Maintain proper clearances of main and connecting rod bearings at all times.

Extreme left: The reclaim is plasticized and other chemicals are added in this milling operation from which it emerges in sheets with much of the appearance of crude rubber

Left: Reclaim is finally forced through this strainer, emerging as rods or ropes, during which operation the last traces of foreign matter is strained out

Circle: Sheeted reclaimed rubber here shown is ready for compounding, looks much like crude rubber

Below: Harvey S. Firestone, Jr., president of the Firestone company, inspects a tire made of reclaim, with only a few ounces of crude rubber

this scrap in maintaining necessary but not critical industrial, commercial, and civilian transport operations during this period are obvious.

It has been estimated that 24,000,000 of our passenger cars may be maintained on the road until the end of 1943, by the use of all practicable methods of conserving, recapping, and the uses of additional rubber (reclaim) for the manufacture of emergency-type tires. (Report of Advisory Subcommittee on Rubber Economics, PIWC.) By the end of 1944 only 22,000,000 of these cars can be kept in operation in this manner, this subcommittee estimates. We have every expectation that by 1945 our national war and other needs can be supplied from synthetic sources.

In order to accomplish these results, the estimate is made that 62,000 tons of crude and reclaim (5,000 to 57,000 tons, respectively) must be used for recapping in 1942. In 1943, 8,400 tons of crude rubber and 104,000 tons of reclaim will be required, while for 1944 the corresponding figures are 10,000 tons and 147,500 tons, respectively. These figures do not appear prohibitive.

Reclaiming Process

In the process of reclaiming scrap rubber, the rubber is not processed so as to recover it actually in its original gum condition. The vulcanization reaction, once carried to completion, is irreversible so far as our present knowledge of rubber technology goes. No known process adequately unvulcanizes rubber. One rubber chemist defines the reclaiming process as "a method of plasticizing and disaggregating rubber." In this condition rubber has a certain degree of tackiness, it is comminuted to some degree, it is somewhat plastic and retains a considerable portion of its original rubber properties of rebound (bounce), of elasticity, abrasion resistance, and tensile strength. Because of its characteristic rubber properties it is excellent filler material to include with crude rubber, eliminating or reducing materially some of the undesirable properties of nonrubber filler materials which may be used for much the same purpose. It, however, is low in these characteristic qualities as compared to crude rubber, especially in its resistance to abrasion, or road wear in service, and thus its presence in large proportions detracts greatly from the life span of tires made with large reclaim percentages and used in heavy or high-speed services. Much of rubber reclaim in peacetime goes into household and industrial articles, footwear, waterproofing, tubing, coverings, and into third and fourth-grade tires. Relatively small amounts are used in second-grade, practically none in first-grade tires.

After removal of nonrubber metallic materials, chiefly wire from the bead, the tires are chopped into small particles in a chopper or "hog" and subsequently is ground to a finely pulverulent state in rolls, sifted to recover and recycle pieces too large for later processing steps. The finer material is passed through a magnetic separator to remove iron and steel particles, hydrocarbon or other softener liquids are added along with caustic soda. These materials soften the relatively hard rubber, and dissolve the cotton cord remaining in the mass. The suspension of rubber, foreign matter and other materials in the oil-and-caustic mixture passes through a devulcanizer, digester, treated with steam, and the rubber suspended is settled out, partially dewatered, washed and again dewatered and settled out. The solid crumbs from this settling are collected in a vacuum filter, dried in a rotary or other externally fired dryer, and is then ready for reprocessing. Oils, pigments, and the other chemical addition agents employed in rubber processing are added, the rubber is blended in a rotary mill, is further milled and worked and is finally strained by extrusion as shown in Fig. 6, is again milled and aggregated, rolled into sheets much as is crude rubber and is then ready for incorporation in any type of finished rubber article for which it may be used.

Variations in Process

Several variations of the reclaiming process indicated above are used, all employing essentially the same principle. In the absence of any considerable use of steam a dilute caustic solution, of 4 to 8 per cent caustic content, is used at 350°-400° F. for 6 to 24 hours' digestion periods. This removes the cotton waste, and apparently a small portion of the sulfur. This desulfurized portion is chloroform-soluble, may be up to 45 per cent of the total reclaim, and contains only 6-8 per cent of the sulfur in the original rubber; it may be revulcanized with up to 5 per cent sulfur to a practically $CHCl_3$-insoluble rubber of high rubber qualities. Plasticizers and softening agents, such as coal tar and petroleum hydrocarbons, are added during the digestion, as shown above. The total yield is about 50 per cent of the scrap.

In the steam process the routine is the same, but employs steam as heating medium and softener along with the other softeners, and concentrated instead of dilute caustic solution, at 375°-400° F. Experiments have shown that 80-90 per cent of the sulfur in the rubber may be removed by treatment with, for example, an aniline solution of aniline sodium, but that the rubber is damaged thereby and the cost is prohibitive under ordinary conditions.

University Experimentation

The importance of reclaiming synthetic rubber is realized and experiments to date show that this product can be partially reclaimed by using large percentages of plasticizers, softeners, and solvents, but that much work yet remains to be done to develop a universal process. The problem is a major one at present at Massachusetts Institute of Technology.

Reclaimed rubber is quicker curing, easier milling than crude new rubber, also has a higher resistance to water damage. For improving its tensile strength reclaim requires a higher percentage of sulfur in vulcanizing. If crude rubber is replaced by reclaim, data show that if the crude is replaced by reclaim in percentages equivalent to the actual rubber content of the reclaim, as much as 12-18 per cent reclaim may be added before any serious loss in wear resistance occurs.

WeldELLS

It's the difference between RIGHT and WRONG —this "selective" reinforcement

BOTH mathematical calculations and practical tests* prove that the bursting stresses in an elbow are greatest at the crotch or inner wall. That's why a special process is employed in producing WeldELLS which provides extra metal in this region of greatest stress as pointed out above. It is the nearest possible approach to the "One Hoss Shay" ideal of absolutely uniform strength throughout.

And it's also one more example of the length to which we have gone in producing WeldELLS to follow sound engineering considerations—considerations which mark the difference between right and nearly right.

An extra value, this—and opposite are listed other extra-value features that are combined in no other fittings for pipe welding. Yet: WeldELLS cost no more!

TAYLOR FORGE & PIPE WORKS, General Offices & Works: Chicago, P. O. Box 485
New York Office: 50 Church Street • Philadelphia Office: Broad Street Station Bldg.

WeldELLS have everything—

No other fittings for pipe welding combine the features found in WeldELL. In addition to that described, they include:

▶ **Seamless**—greater strength and uniformity.

▶ **Tangents**—keep weld away from zone of highest stress—simplify lining up.

▶ **Precision quarter-marked end**—simplify layout and help insure accuracy.

▶ **Permanent and complete identification marking**—saves time and eliminates errors in shop and field.

▶ **Wall thickness never less than specification minimum**—assures full strength and long life.

▶ **Machine tool beveled ends**—provides best welding surface and accurate bevel and land.

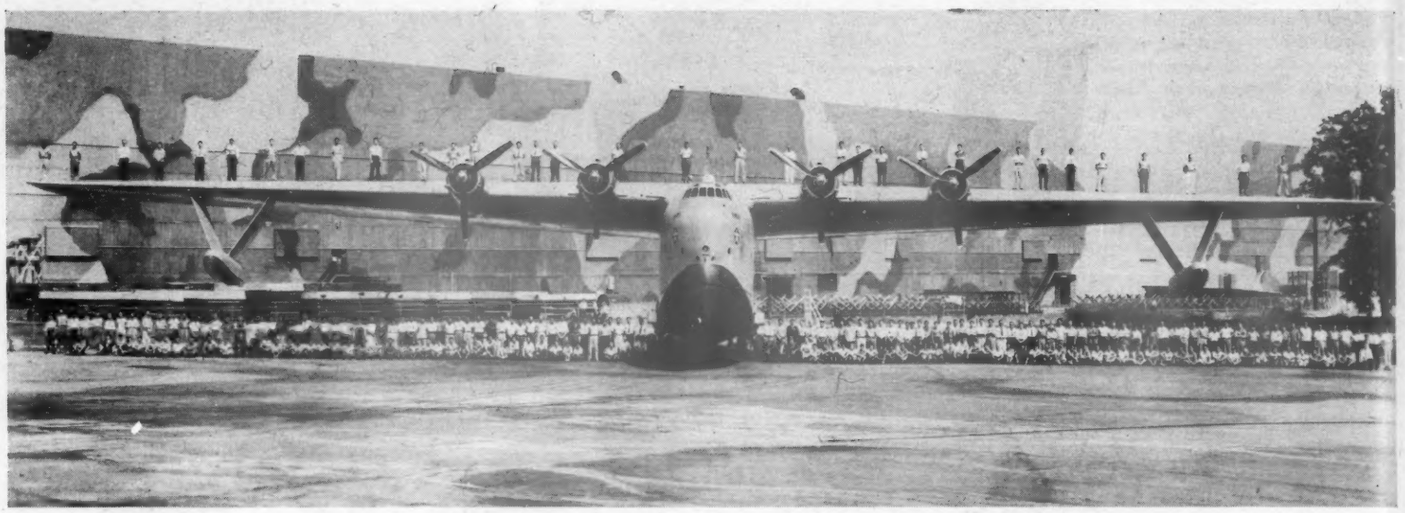
▶ **The most complete line of Welding Fittings and Forged Steel Flanges in the world**—insures complete service and undivided responsibility.

* The amount by which stress is greater at the crotch in a fitting having uniform wall thickness depends only on its radius. Mathematical analysis (specifically the Lorenz formula) shows the stress at the crotch to be:

$$S = \frac{pr\,(2R - r)}{2t\,(R - r)}$$

Where S = Bursting stress, lbs. per sq. in.
p = Internal pressure, lbs. per sq. in.
r = ½ inside diameter of fitting (O.D. if Barlow's formula is desired).
t = Wall thickness in inches.
R = Center line radius of fitting, inches.

Numerous tests by the Research Division of Taylor Forge show the formula given above to be somewhat on the conservative side.



Aviation will be one of the largest consumers of tomorrow's rubber. In addition to the petroleum-derived superfuel and lubricants used by the four huge engines—about 9,000 hp.—of this Martin cargo plane, several hundred pounds of synthetic rubber are used in its construction. Landing wheels use great, 6-ft. diameter tires; fuel tanks are insulated with rubber, a layer of special bullet-hole-closing rubber is used to make its fuel tanks bulletproof and rubber is used as insulation and shock-absorbing material all through the ship. It is the new Martin Mars freight-carrier plane, 140,000 lb. of flying boat and is the pioneer in what is expected to be the solution of the submarine menace and probably of the fast freight needs of tomorrow

Our National Dilemma—What Of Our Future Rubber Supply?

By ARCH L. FOSTER

THE development of a million-ton synthetic-rubber industry by the American people in 2 years, under fire of the greatest war of all time, is the most colossal single effort ever made by the human race. Every other development is dwarfed when compared with the magnitude of this painfully critical undertaking. No extension of truth exists in the statement that the fate and the future welfare of a nation hangs on our ability to synthesize rubber in adequate quantities—in time.

It is quite as true, many believe, that when this conflict is ended, the American people will be faced with the greatest decision in its national history. The question is: Shall we depend in future on rubber from foreign sources, outside our continental boundaries, or shall we maintain this industry within our borders under the direct physical protection of the Stars and Stripes?

Because of the large number of factors which will be involved in consideration of the problem the matter of reaching an intelligent and, above all, a *safe* conclusion will not be so simple as the flat statement above indicates. Summarizing briefly our present war-emergency situation, the decision to produce synthetic rubber was forced upon us. Our peacetime rubber production was centered 10,000 watery miles away. Production of crude rubber in the British and Dutch East Indies is practicable on the basis of three important factors: soil, climate and labor. Low-cost labor of the East has been available at 10-15 cents per day. Climate conditions are more nearly those of the Amazon Valley—original home of Hevea Brasiliensis, the rubber tree—than in any large area that is available on the globe, it appears. The tropical soil of those islands, the heavy rainfall, the total absence of frost at the rubber-growing altitudes all collaborated to promote rubber producing there under support of "patient" British and Dutch money. Long-distance transportation in itself offers no obstacle worthy of serious thought.

The location of this region alone made it highly vulnerable to military invasion. Its great distance from the mother countries and the financial and transportation problems of maintaining adequate defense forces aggravated the job of making this area safe from enemy attack. These facts have been obvious to military leaders in Europe and America all along. Most of the citizens of western nations were too busy to consider the matter seriously; the "it can't happen here" attitude toward our affairs in general was applied equally nonchalantly to the matter of rubber supplies. The cataclysm of Singapore, the "Impregnable," woke us painfully to the fact that, like the tramp, our car's "shoes" were wearing out and we would soon be "on our feet again," that is, immobile and without our chief and most useful means of transportation.

Price of National Safety

The price we can afford to pay, then, for wartime rubber is the price of national safety, the insurance premium against national oblivion. So obvious is that fact that, long since, the cost of rubber intermediates and rubber itself has been estimated by federal officials and industrial technologists not in terms of millions of dollars per year but in tons of the supercritical steel required to produce the needed quantity. And our expenditure of steel is limited only by our emergency capacity to produce steel and fabricate it. No other considerations have been given mind room, no other attitude could be tolerated. And Japan and Germany will be smothered under a blanket of American freemen-made synthetic rubber.

It is of far more importance to have a look, even now while the issue is still joined on a dozen battlefronts and the outcome is not certain as fact, at the controlling factors which will obtain when the war is over and won. Assume that the Indies is restored to control of the United Nations and that, at latest and even though the present rubber trees may be destroyed by a retreating enemy, within 6 to 8 years these plantations are again producing adequate amounts of rubber for world consumption. Assume that, for the time at least, the sea lanes are open to the shipping of the world, the enemy exhausted and too thoroughly disarmed to be a danger. Until that time arrives military economics must rule—that program is cheapest which makes the required amount of material with some to spare, which gets it to the right place at the right time—before it is needed. Monetary considerations which might curtail that program are unthinkable.

Later, with peace again assured, the problem changes its basis of evaluation. Most of Europe and much of Asia will be devastated, homes and factories destroyed, credit nonexistent; whole nations will be bankrupt, in terms of prewar economics. Restoration of trade will be one of the mountainous problems to solve. Every possible avenue for production of commercial and industrial goods will be tackled by debt-ridden countries to retrieve in some degree a measure of prosperity, and our own country will be no exception.

Mathematical economics will supersede the military kind. The relationship between over-all cost of an article and the net price obtainable for it

1915
1918
1921
1924
HUCR
1927
BENZOL EQUIVALENTS
1930
OCTANES
1933
65 OCTANE
1936
78 OCTANE
1939
90 OCTANE
1942
100+ OCTANE
We have Witnessed the Parade of Octanes
1943 Synthetics
SAYBOLT LABORATORY, INSPECTION AND ENGINEERING FACILITIES ARE AVAILABLE FOR THE DEVELOPMENT AND PRODUCTION OF SYNTHETICS.
LABORATORY AND SAMPLING SERVICE
AVAILABLE DAY AND NIGHT
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E. W. SAYBOLT & COMPANY
INSPECTORS OF PETROLEUM
PETROLEUM BUILDING
HOUSTON, TEXAS

FIRE and how to fight it!

HOW DO YOU KILL

FLAMMABLE LIQUID BLAZES?

Q. What are flammable liquid fires?

A. They are fires in oils, gasoline, solvents, paints, lacquers, and the like. Authorities call these Class "B" blazes and recommend extinguishers with a *smothering* or *blanketing* action.

Q. Will every type of extinguisher work on all kinds of flammable liquid fires?

A. No! Water streams, for example, are usually ineffective and extinguishers which employ a liquid stream will generally not handle three-dimensional blazes.

Q. What is a three-dimensional fire?

A. It is a fire which burns at more than one level, as when a container ignites and spills a flowing stream of burning liquid over its sides. Carbon dioxide extinguishers readily handle this type of fire. Work from the bottom up. Kill the fire at the lowest level first.

Q. What is a running fire?

A. It is a flammable liquid blaze which occurs when a flowing stream becomes ignited. You fight this fire by working against the flow of the liquid. If a pipe is leaking, start at the extreme edge of the fire and work back toward the pipe. If a container is spilling its burning contents, work toward the container.

Q. What is a spill fire?

A. This is simply a fire resulting from liquid spilled on the ground or on the floor. Don't try to kill all of this fire at once, if it covers a large area. Start at one point, smother all flames there and continue, part by part, until the entire fire is out.

If you are outdoors, *keep wind at your back.*

Q. How about fires in open vessels?

A. Always "bank" stream from foam or vaporizing liquid extinguishers off inside wall of container. Don't squirt directly on burning surface. With carbon dioxide units, aim discharge at nearest portion then work up on fire with slow sweeping motion.

MAKE EXTINGUISHERS LAST LONGER

Since December 1941 Walter Kidde and Company has had an unusual war job . . . to make products that *save* fighting men's lives. These products include high pressure containers for aviation use, special type built-in extinguishing systems, crash trucks, and various flotation equipment.

Since we have fewer Kidde extinguishers* to sell, we are trying to make your existing fire fighting units more effective.

If you want reprints of this series of advertisements, just write to

Walter Kidde and Company, Inc., 1134 West Street, Bloomfield, New Jersey.

Kidde

*formerly known as "LUX" extinguishers

in competition with other similarly purposed products must be maintained, even in the face of those arch disturbers of economic balance, governmental subsidies. We must be paid as much for an article as it costs to make it, or business, industry and commerce cannot go on. If a product cannot compete in cost with another, the less costly product will survive, the more costly will either disappear or a reduction of its cost to a competitive value will be made. This fact will be as true of rubber as of flour, radios or rabbit steaks.

Commentators tell us that natural rubber can be produced under prewar eastern conditions and sold for as low as 5 to 6 cents per pound. If we assume—actual figures are not available—that the cost of transportation of the crude rubber to this country is equal to no more than 4 cents, a total cost of crude rubber from the East laid down in America may be estimated at 10 cents per pound. This value is certainly not exact, but may be considered as of the order of magnitude of the actual cost, granting that the first cost assumption is correct.

Difference in Rubber Costs

Ten cents per pound, then, is the initial cost figure with which synthetic rubber must compete in that phase of the industry. Can rubber be synthesized for 10 cents per pound, delivered from the synthesizing unit across the yard via conveyor to the compounding plant? In the quantities heretofore manufactured in this country, with the heavy overhead traceable to expensive, privately financed research, heavy plant amortization charges, high wages for perfectly trained, skilled workmen, high cost of intermediates made in small quantities, by processes not yet well enough developed to have reached reasonable expectable efficiency, it is extremly doubtful if rubber can be synthesized at a cost anywhere near the 10 cents per pound price. Peacetime prices for intermediates have been quoted at from about 15 cents up. Wartime claims for costs of butadiene for example range as low as 6 to 7 cents per pound. Since rubber cost is a sizable but by no means the greatest factor in the price of a finished tire and since cost of other materials may be higher than that of the rubber used, rubber prices will not control but will inevitably affect importantly the final price of tires and other rubber goods.

Two and a half years ago the head of a large American rubber company, itself heavily on the debit side of the ledger on expenditures for synthetic-rubber research, told the U. S. Government that on a large scale synthetic rubber can be manufactured for about 25 cents per pound. At that price the synthetic variety can compete with prices as they existed immediately before the war started. But, from a purely mathematical dollars-and-cents view of the initial cost, synthetic rubber cannot compete with a price of 6 to 10 cents per pound, with our present knowledge of its technology.

At that same meeting, the U. S. Government was urged to consider, not so much the extra cost of making synthetic rubber in America or of building standby plants for emergency purposes, but to study the cost of not building such plants. The cost items for failing to provide adequate emergency rubber capacity within the confines of our own military protection are three—the maintenance of a police force over the rubber-producing regions which could withstand the attack of a first-class military power situated in that immediate neighborhood, a cost which doubtless would run into hundreds of millions of dollars annually; the cost of emergency building of such capacity as we are now doing, which eventually will be a billion dollars or more, it is estimated, the most expensive way of providing the capacity; or, the capacity can be built or maintained, in operation or as standby, before

emergencies arise, at a cost which history may prove to have been unnecessary. The "unnecessay" possibility is considered remote.

On the basis of comparative costs, between 10 cents for natural and 25 cents for synthetic rubber, the difference in cost to this country is 15 cents per pound. Assuming for calculation purposes that in our accelerated rate of consumption which may be expected after the war is won, we shall use a million tons—2 billion pounds—of rubber annually, the additional cost for synthetic rubber would be $300,000,000 per year. To insure adequate supplies of rubber under all conditions we could then afford, from a purely financial view alone, to expend this sum in some type of outlay which will make this country safe from enemy aggression on rubber supply. It can be expended in any manner which will insure the greatest degree of safety at the lowest over-all cost.

There is every reason to believe, however, that the cost of synthetic rubber when produced in very large quantities, can be reduced much below any cost figures which have been estimated in the past. Such has been the history of natural rubber; such has been the history of every industrial development which has reached imposing production proportions. In the early history of electric refrigerators, for example, units of household size cost up to $1,000, with a life span of 3 to 5 years. In recent years the same and better equipment has been sold at prices of the order of $175-$200 with a normal period of satisfactory operation of 5 to 10 years. The difference is the development of more efficient technology, better manufacturing processes and a general over-all cost reduction throughout the manufacturing cycle.

As to quality and properties of rubber, at about the turn of the century the rubber of a tire would last for 3,000-5,000 miles driving at speeds of 30-50 miles per hour. A 1942 first-grade tire lasts for 25,000-30,000 miles at 50-75 miles per hour. The entire difference is that of technology—better "know how," better fabrication practices, better rubber quality, all developed by and from increased knowledge of how to finish rubber and how to build tires. We have every reason to believe that this history will be repeated with synthetic rubber and that the period of development will be reduced to a very few years, a much shorter time than was required to bring natural rubber to its present state of perfection.

Our reserves of material necessary to produce adequate supplies of synthetic rubber offer no slightest cause for concern or uncertainty. Estimates of the amount of crude petroleum or its natural-gas equivalent give not more than about 65,000 bbl. per day as the total requirements for our present stepped-up rubber consumption. If butadiene is made from alcohol from grains one estimate from a qualified authority states that 80,000,000 bu. of corn annually is adequate, and with 10 to 20 per cent more for alcohol to make styrene with benzene from coal or petroleum. Recent summations of statistics on available butane alone, from refinery gases, natural gas and other sources, credit the United States with nearly 200,000 bbl. of "available" butane, with that much more in existence but less readily available in economic quantities. This additional butane could be recovered, most of it, if the demand is sufficient, giving the industry time to relay its plans, plants and arrangements in an economic manner. By coal and shale distillation, hydrogenation and cracking these amounts of hydrocarbons can be increased hugely.

Large quantities of C_4 (butane and butene) hydrocarbons are producible by catalytic as well as thermal-cracking and conversion processes. The field of catalysis is even now opening the door of knowledge only slightly, and tomorrow tells little of what is to come but promises tremendous developments. For even our present exaggerated requirements for aviation superfuels and the million-ton rubber program enough butane is available naturally and can be formed by known processes to supply both demands from butanes alone. And we have millions of acres of grain lands where rubber can be grown on stalks if need be. In recent years millions of bushels of grain have been withheld from the market because of lack of customers. Recently a publishing company announced that the waste lignin solution from paper making is sufficient in the United States and Canada alone to produce 900,000 tons of butadiene annually. There is no dearth of raw materials for synthetic rubber.

The mere matter of the $300,000,000 estimated difference in the cost to the American nation of its rubber needs supplied from natural and from synthetic sources is by no means the whole story which must be considered in arriving at our conclusion. An army of occupation is not a creative agency in an economic sense; it is a consumer. When all is studied carefully the dilemma reduces to one pair of horns; what are we willing to pay, what will be good insurance to pay for safety, in a military, in an economic sense; how far are we justified in going, to make our civilization impregnable so far as the indispensable rubber supply is involved?

Higher Oil Taxes May Be Added

WASHINGTON, D. C.—Sellers of lubricating oils may add the amount of the tax authorized in the 1942 revenue bill to their maximum prices under Price Schedule 88, Office of Price Administration has ruled. The added tax is 1.5 cents per gallon.

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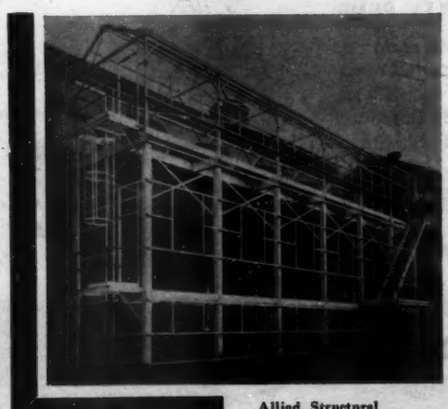

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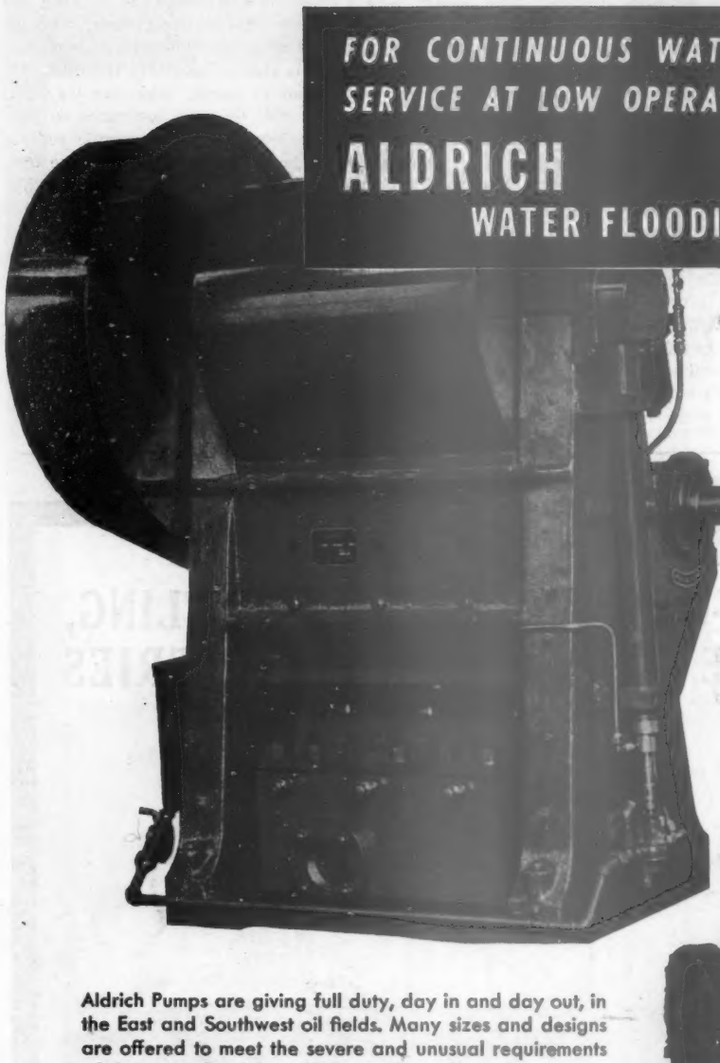

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Allentown, Pennsylvania

Properties of Synthetic Rubber

(Continued from Page 90)

In aviation, for example, rubber fabrications are used in deicing wings and propellers; rubber being a nonconductor develops static electric charges which may produce sparks and fire the ship's fuel. By compounding synthetic rubber (neoprene) with graphite enough conductivity is built into the product to prevent dangerous potentials developing. The same idea is employed in rubber gasoline hose to prevent sparks and the resultant disastrous fires so frequently occurring in the past with natural-rubber hose.

The last of applications in which the properties of synthetic rubbers are much superior to natural may be extended ad infinitum, but these few instances illustrate adequately for our purpose the fact that synthetic rubber already has a world of uses in which natural rubber cannot compete successfully.

Variation of Properties by Processing

Our foremost synthetic-rubber authorities have deduced that the degree of unsaturation of synthetic rubbers varies between about 80 and about 90 per cent of the theoretical; that is, one double bond per butadiene unit involved, and one triple bond per nitrogen atom, or acrylonitrile group present. Careful tests by a variation of the Kemp-Wijs iodine-addition method show that for butadiene polymer (buna 85, etc.), the average percentage based on this theoretical consideration is 86; for butadiene-styrene (buna S type), about 80; and for butadiene-acrylonitrile about 85. The loss or reduction of unsaturation is attributed to crosslinkings, wherein two or more double bonds are broken to reunite each with a similar broken bond in another group, forming what appears to be "cross braces" within the molecule. To this degree of crosslinkage may be credited the greater rigidity and greater resistance to oxidation aging of synthetic rubber, in the opinion of many rubber chemists. The unsaturation of butyl rubber is accredited as being only 1 or 2 per cent of that of natural rubber, which again explains butyl rubber's resistance to oxidation aging, to solvents and to strong chemical action. The specific properties of butyl rubber are discussed in greater detail in another article in this issue.

Heat resistance of various synthetic rubbers compared to natural rubber is shown in Table 4, in which "smoked sheet" is the natural product. Note that the temperature of blowhole formation, taken as the criterion of incipient decomposition by heat for smoked sheet is 198° C.; for the synthetics these temperatures range from 233° to 244° C. Additional curing time greatly improves synthetic rubber as shown in Table 5, while very little improvement is obtained in natural rubber. These reactions will be discussed further under "Manufacture of Synthetic Rubbers," elsewhere in this issue.

The fact that synthetic tire rubber resists oxidation more than does natural rubber means that it breaks down more slowly and to less degree when milled or worked, therefore, as will be shown under "Manufacture," synthetics must be worked more and longer, with a "tighter" mill (one in which the interstices between the rolls are smaller) and at lower temperatures than are best for natural-rubber working. This necessitates greater milling capacity for synthetic than for natural-rubber factories for any given throughput, and adds to the over-all cost correspondingly. The natural product is softened and milled properly at 180°-220° F.; synthetic rubbers generally become "short"—that is, will not extend to any great degree without pulling apart—under such conditions and assume a condition called "nervy," at such temperatures. The break-

down requires a "cold" mill, temperatures of the order of 100° F., although different laboratories are not in general agreement on this. Doubtless their different claims are due to differences in processing to prepare their several products and thus to differences in the crude product which they process in the milling-compounding operations. Synthetic rubbers are much less "tacky" than naturals; softeners, plasticizers and even cements are used to give the tackiness—stickiness—which is necessary for perfect mixing and compounding results. The effects of various fillers and pigments, plasticizers, softeners, accelerators and elasticizers will be discussed further under "Manufacturing."

Acrylic oil-resistant types may be varied to improve either low-temperature flexibility—these types normally become stiffer than natural rubber at very low temperatures—or solvent-swelling resistance, at the expense of the other property. Highly accelerated acrylic rubber loses some of its heat resistance in gaining plasticity and speed of curing and this property loss is offset in some degree by vulcanization without added *elementary* sulfur. Compounds containing large proportions of thermal-decomposition type carbon blacks have maximum resistance to swelling in solvents, are rubber-like, have relatively low tear resistance but are not excessively hard and are extensible, i.e., have good stretchability. Excessive hardness at low temperatures may be alleviated by proper softener treatment, the butyl sebacates, phosphates, and phthalates reducing low-temperature hardness, diethylene glycol phthalate and soft coal tar increasing that hardness.

Acrylic-type rubbers are the more resistant to solvent swelling as the nitrile content of the product increases. Correspondingly low-temperature hardness increases with nitrile content. Therefore these two properties are interdependent, say authorities, one being improved, so far as our present technology knows, at the expense of the other. The Shore hardness of a 46 per cent nitrile rubber at 0° C. (32° F.) is 90, equal to that of a 26 per cent nitrile rubber at minus 25° C. (—13° F.).

Butyl-Rubber Properties

Obviously, so far as tire rubber is involved, butyl rubber is an ersatz or substitute material. Its wear qualities, probably the most important quality in tire rubber to the individual user, are inadequate in the present product; tensile strength, rebound and hysteresis properties in general are of too low values to make it a product to be considered seriously as a proper material for tires under normal peacetime conditions. Its inertness, resistance to oxidation aging, its very high dielectric strength and impermeability to gases, and especially its extreme resistance to the action of strong acids, bases and other reactive chemicals make it a premium material for various industrial and commercial applications, and authorities see for butyl rubber a large and growing field of application. It loses very little of its dielectric strength even after several days' immersion in water, due to its impermeability.

Barely enough of diolefin is included in butyl rubber to permit vulcanization. The polymer of isobutene alone (vistanex) is not vulcanizable, because of the absence of double carbon-carbon bonds. Butyl rubber is odorless and colorless. It is produced at very low temperatures, does not require mastication before compounding and is tacky enough to facilitate fabrication. It is not attacked appreciably by ozone even under conditions which destroy natural rubber in a few minutes. Strong acids such as sulfuric, nitric and hydrochloric have very little effect on it, even after several days of exposure. Only aqua regia, a mixture of nitric and hydrochloric acids, affects it appreciably.

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The rebound of butyl rubber is low, one-fourth that of natural rubber or less, at room temperatures; when heated, say to the temperature of boiling water, this rebound inexplicably increases to approximate that of natural rubber at atmospheric temperatures. Butyl must be cured at higher temperatures, its tensile strength increasing with length of curing time. It will not covulcanize when mixed with natural rubber, and must be used with itself.

Butyl is susceptible to petroleum and aromatic solvents and may be used advantageously in cements where toxic aromatic solvents may be replaced with inert aliphatic naphthas. It is especially useful for gas masks and protective clothing for wear in war-gassed areas, fires; its impermeability to gases gives better protection to the wearer, its inertness to chemical effects give longer useful life, a most useful property under adverse field conditions such as obtain in warfare. Acid resistance is shown in more detail in Table 6.

Tread Life of Butyl

In making tires, butyl rubber treads show a life of 20,000 miles when used at speeds not above about 40 miles per hour, using rubber which contained the smaller amount of diolefin giving the lowest hysteresis value. With about twice as much diolefin, such as butadiene, current road tests are expected to show much better wear results by increasing the unsaturation without damaging desirable properties to an equivalent degree. Impermeability to gases makes butyl rubber especially efficient in tire tubes, where abrasion resistance is decidedly secondary in importance to air retention and aging resistance.

TABLE 7—DENSITY VALUES AT 25° C.

Name—	Density grams/cc.
Neoprene CG	1.2307
Neoprene E	1.2384
Neoprene FR	1.1406
Neoprene GN	1.2290
Buna-S	0.9291
Buna-S	0.9358
Buna-S	0.9369
Buna-S	0.9390
Chemigum IV	0.9391
Hycar OS-20	0.9385
Hycar OS-30	0.9303
Chemigum I	1.0135
Hycar OR	0.9992
Perbunan	0.9684
Thiokol RD	1.0564
Thiokol A	1.5983
Thiokol FA	1.3298
Butyl B-1.45	0.9175

In any consideration of the properties and serviceability of synthetic rubber the facts that our technology of the natural product is very extensive while that of the synthetic material is brief and inadequate must have a strong influence on our conclusions. Always must be kept in mind that comparisons of present products recognize the fact that synthetic rubber of today is probably far inferior to that of tomorrow, that improvement in synthetic rubber will progress in the next 5 or 10 years much faster than can be expected in natural-rubber processing. The made-to-order possibilities of synthetic rubber are so wide and so important, properties desirable for special or individual uses may be varied over so wide range, often at the expense of properties not seriously important for that purpose, make synthetic-rubber manufacture a fruitful field for endeavor by the rubber chemist and hold far-reaching promise for the rubber we will use in the future.

Methods of Manufacturing Synthetic-Rubber Intermediates

(Continued from Page 46)

than would be required if subatmospheric pressure were used. The obvious objections to the use of vacuum are the vacuum blowers required (highly strategic equipment) and the danger of getting oxygen into the system. Altogether, aside from the consumption of butylene by oxidation and the production of undesirable aldehydes in the finished product there is the much greater danger of explosions. Not only can such explosions be caused by air-hydrocarbon mixtures, but they may be caused by the accumulation of peroxides in the products.

Several of the plants originally designed to use *n*-butane as a charging stock were switched to *n*-butylene early in the summer of this year. The butylene was to come largely from catalytic cracking units installed to produce aviation-gasoline base stock, and, according to newspaper accounts at the time, would not interfere with the production of alkylate. If production of ordinary motor gasoline is seriously curtailed by gasoline rationing and by increasing fuel-oil production, it would seem probable that these catalytic crackers will have to produce some very high yields of butylene. Unless crude-oil runs to stills are increased the charge to thermal units will be decreased when these catalytic crackers go on stream. A nice piece of laboratory control work will be required to maintain the necessary production of butylene for alkylation plants and these butadiene plants.

It should be observed that the production of butylene for charge to the butadiene plant under these conditions is a substitute for the dehydrogenation of *n*-butane described above and shown in Fig. 2. In other words, a part of the investment in the catalytic-cracking unit should be allocated to the production of butylene (and therefore of butadiene), if a true picture of the cost of producing butadiene is to be had. If this is not done, then the value of the butylene should be based on the cost of the gas oil charged to the catalytic cracker. A pound of butylene would be equal in value to the cost of a pound of gas oil plus the cost of extracting the buytlene from the B-B cut in which it is found leaving the cracking unit. The quantity of butylene required to produce a tone of butadiene per year has been variously estimated at 70 to 85 per cent of the amount of *n*-butane needed. To produce the 283,000 tons of rubber listed by the Baruch committee as coming from butylene will require somewhere between 10,000 and 16,000 bbl. of butylene per day.

Several processes have been used for converting ethyl alcohol into butadiene. During World War 1 the Germans converted alcohol into acetaldehyde, then to aldol, hydrogenated the aldol to 1,3-butylene glycol and then dehydrogenated this product to butadiene. They are apparently using the same process today, except that they are starting with acetylene (from calcium carbide) instead of alcohol. The Russians developed a catalytic process (Lebeder) for dehydrating and dehydrogenating alcohol to butadiene.

$$2\ C_2H_5OH \rightarrow C_4H_6 + 2\ H_2O + H_2$$

Similar processes were developed in Poland and in this country, and a sizable portion of the total butadiene made will come from alcohol by such a catalytic process.

Ethylene may be converted to butadiene by a variety of methods. By straight high temperature noncatalytic treatment, ethylene can be made to produce appreciable quantities of butadiene. Better yields will be obtained, however, if the ethylene is first converted to *n*-butylene or to ethyl alcohol, and the derivative is then treated catalytically by one of the processes mentioned above.

Acetylene, which is customarily made by treating calcium carbide with water, may also be produced from natural gas or liquid hydrocarbons by very high temperature treatment. Such treatment may be conducted by regenerative stoves or by means of an electric arc.

Acetaldehyde, which has been mentioned above as coming from the oxidation of ethyl alcohol or by hydration of acetylene, can be prepared in other ways also. Numerous patents are in existence covering processes for the oxidation of hydrocarbons to acetaldehyde.

Isobutylene, used in making butyl rubber, exists in relatively large quantities in cracked gases from normal refinery operations. Its boiling point, however, is so close to that of butylene-1 and of butadiene that other methods than fractionation must be used to separate it in a high state of purity. Details of these methods are not available for publication.

Styrene, or phenylethylene, may be produced by catalytic dehydrogenation of ethyl benzene or by high temperature noncatalytic cracking of petroleum. Most of the styrene to be produced will be made from ethyl benzene by catalytic dehydrogenation. A small amount will be produced by high temperature cracking, but in this case the chief difficulty lies in separation of the styrene from the accompanying undesirable compounds.

Part of the ethyl benzene to be produced will be made by chemical companies using $AlCl_3$ to catalyze the alkylation of benzene with ethylene, as described by Dr. Willard H. Dow at the American Chemical Society meeting at Buffalo in September. Yields of ethyl benzene per pound of $AlCl_3$ have been greatly improved over earlier figures. The balance of the ethyl benzene will be made largely by oil companies using phosphoric acid or silica-alumina catalyst in equipment similar to catalytic polymerization plants. Ethylene-rich gas, free from other olefins, or ethyl alcohol will be passed with a large excess of benzene over the catalyst at elevated temperatures and under high pressure. Unreacted benzene will be recycled and there is some hope from the literature that the polyethyl benzene byproduct can be reacted with more benzene to produce increased yields of ethyl benzene.

The C_5 cut from the high-temperature noncatalytic cracking of petroleum contains relatively large quantities of the diolefins, isoprene, piperylene and cyclopentadiene. The technique worked out in the separation of butadiene may be used in a similar fashion to recover these diolefins also. By a combination of fractionation and solvent extraction isoprene of excellent purity may be so prepared.

Acrylonitrile, which is used in making perbunan (or buna-N) type rubber, requires a supply of ethylene as well as the —CN radical. It is unnecessary to point out the vast quantities of ethylene going into fuel gases in United States refineries. By treating ethylene with hypochlorous acid we get ethylene chlorhydrin:

$$C_2H_4 + HOCl \rightarrow HOC_2H_4Cl$$

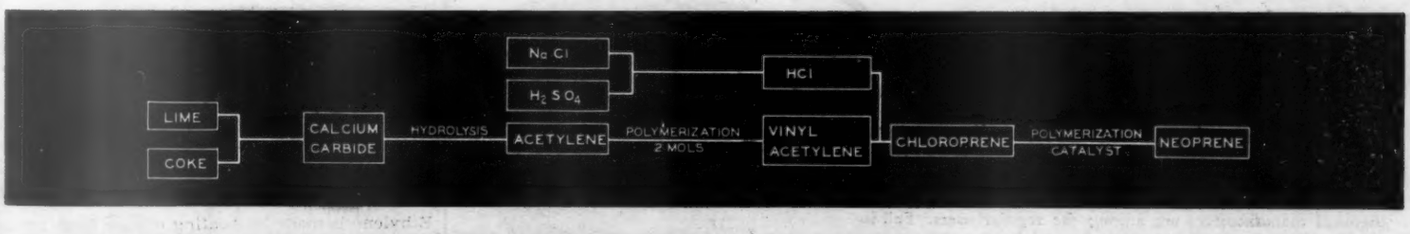
By reacting this material with sodium cyanide we can obtain hydracrylic nitrile, which gives acrylonitrile on dehydration.

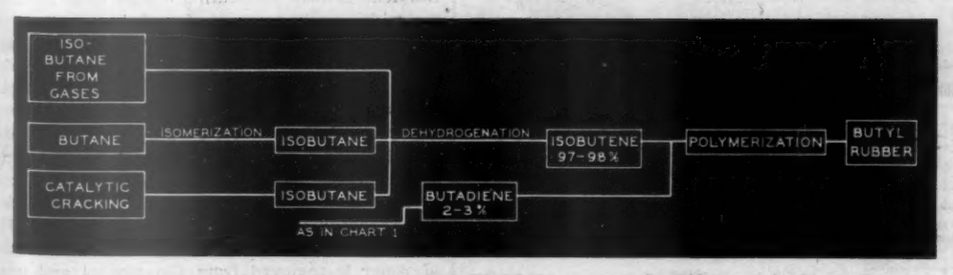
$$HOC_2H_4Cl + NaCN \rightarrow HOC_2H_4CN + NaCl$$

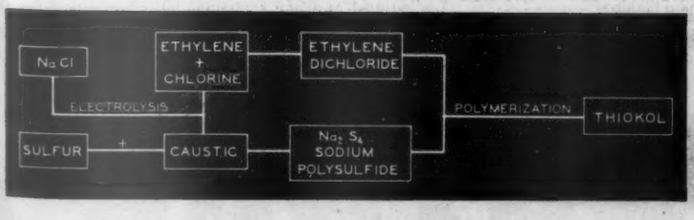
$$HOC_2H_4CN \rightarrow C_2H_3CN + H_2O$$

Other methods for producing acrylonitrile can doubtless be used, but they will probably require the use of ethylene also.

Among the outstanding achievements in recent years has been the development of the methacrylate resins. They are produced by polymerizing the esters of methacrylic acid, although usually







Charts showing preparation of (top) neoprene rubber, (center) butyl rubber, and (bottom) thiokol

the methyl ester alone is employed. The petroleum industry might be the source of these materials if isobutyric acid or acetone is used to produce the methacrylic acid. Thus esters of alpha or beta halogenated isobutyric acid yield methacrylic acid upon dehydrohalogenation.

$$(CH_3)_2C(Cl)\,COOR \rightarrow CH_2 = C(CH_3)\,COOR + HCl$$

Acetone may be converted to acetone cyanhydrin by treatment with HCN and this product may be esterified and dehydrogenated to produce the methacrylic ester.

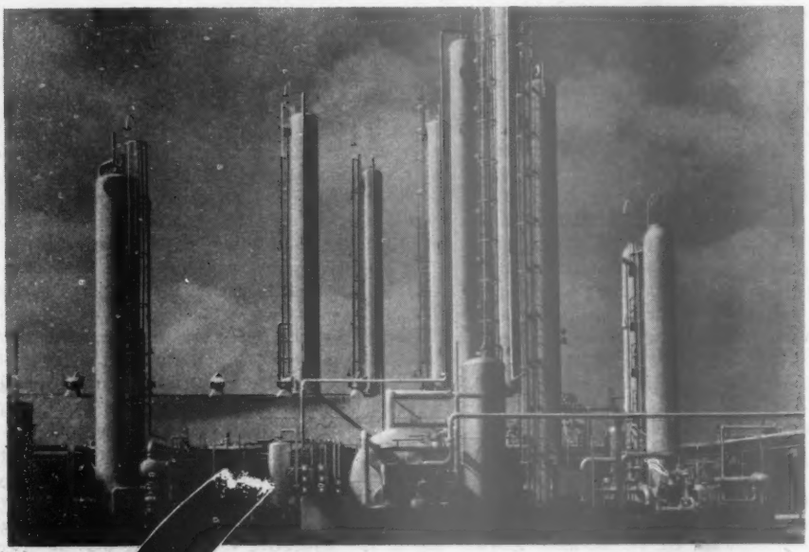
$$CH_3COCH_3 + HCN \rightarrow (CH_3)_2C(OH)CN$$

$$(CH_3)_2C(OH)CN + H_2SO_4 + ROH$$

$$\rightarrow CH_2 = C(CH_3)COOR + NH_4HSO_4$$

Production of acetone on a large scale by the petroleum industry is already an accomplished fact. Large supplies of propylene are available in nearly every refinery and the production of isopropyl alcohol and acetone from this propylene is a simple matter, if equipment can be made available.

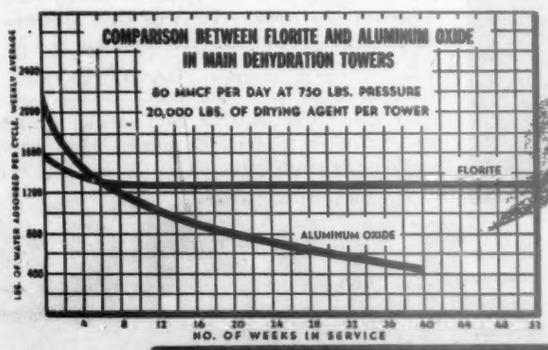
As production of the new synthetic rubber gets under way, there will doubtless be a demand for other types of materials heretofore supplied the rubber industry by the petroleum companies. It is hardly likely that exactly the same products will be satisfactory for buna-S or buna-N or butyl rubber that have been most effective in using natural rubber. Research in the rubber industry, and research in the petroleum company laboratories will discover new products that will increase the life and usefulness of these new rubbers, new products to be made on a large scale from petroleum.



n Dehydration for REPRESSURING

the approved Desiccant is Florite*

The chart below represents the long-term efficiency of FLORITE as a drying agent for natural gas. FLORITE* is now the approved desiccant in many such operations, especially those for repressuring. Is equally effective in the treatment of various other gases and liquids. Will selectively adsorb 4 to 20% its weight of water—is regenerated by heating to 350° F. Nationally known chemical manufacturers are among the regular users. Full information on request.


COMPARISON BETWEEN FLORITE AND ALUMINUM OXIDE
IN MAIN DEHYDRATION TOWERS
60 MMCF PER DAY AT 750 LBS. PRESSURE
20,000 LBS. OF DRYING AGENT PER TOWER
FLORITE
ALUMINUM OXIDE
LBS. OF WATER ADSORBED PER CYCLE, WEEKLY AVERAGE
NO. OF WEEKS IN SERVICE

*Trademark Registered

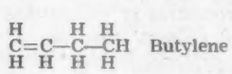
The long-sustained effectiveness of FLORITE in adsorbing relatively large amounts of water is shown. Note that the results were more and more favorable to FLORITE as weeks passed.

FLORIDIN COMPANY, INC.
178 LIBERTY ST. ADSORBENTS WARREN, PA.

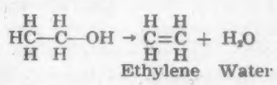
The ABC of the Synthesis Of Rubber

(Continued from Page 31)

mal methods, heating the butane to temperatures so high that partial decomposition of the molecule occurs, which results in the formation of butadiene. Or the same result may be obtained by heating butane in the presence of a catalyst, such as chromic oxide, bauxite, aluminum oxide and other materials, which catalyst promotes the removal of hydrogen without becoming involved in the final product. In each case some butylene,

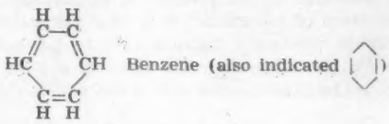


is formed, which may be recirculated through the process to be reduced further to form additional butadiene. The formation of butadiene from butane by either thermal or catalytic methods makes the same product; it may also be made by heating ethane, propane, and other natural gases to extremely high temperatures of 1,200° F. or higher. Butadiene may also be made from alcohol from corn and grains by a method of removing a molecule of water from the alcohol and combining two molecules of the resulting ethylene as well as by other methods for effecting the combination.

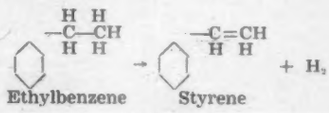


Butadiene may be made from corn by fermenting with a special ferment to form either butyl alcohol or butylene glycol by methods which will not be illustrated here. By whatever method is used the crude butadiene is purified by distillation and by absorption or extraction in special solvents which dissolve the diene but do not dissolve the impurities present, and the purified butadiene is easily recovered from the solvent.

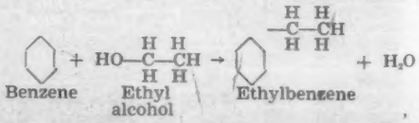
Styrene, the other main ingredient of tire type—buna-S—rubber is made from benzene.



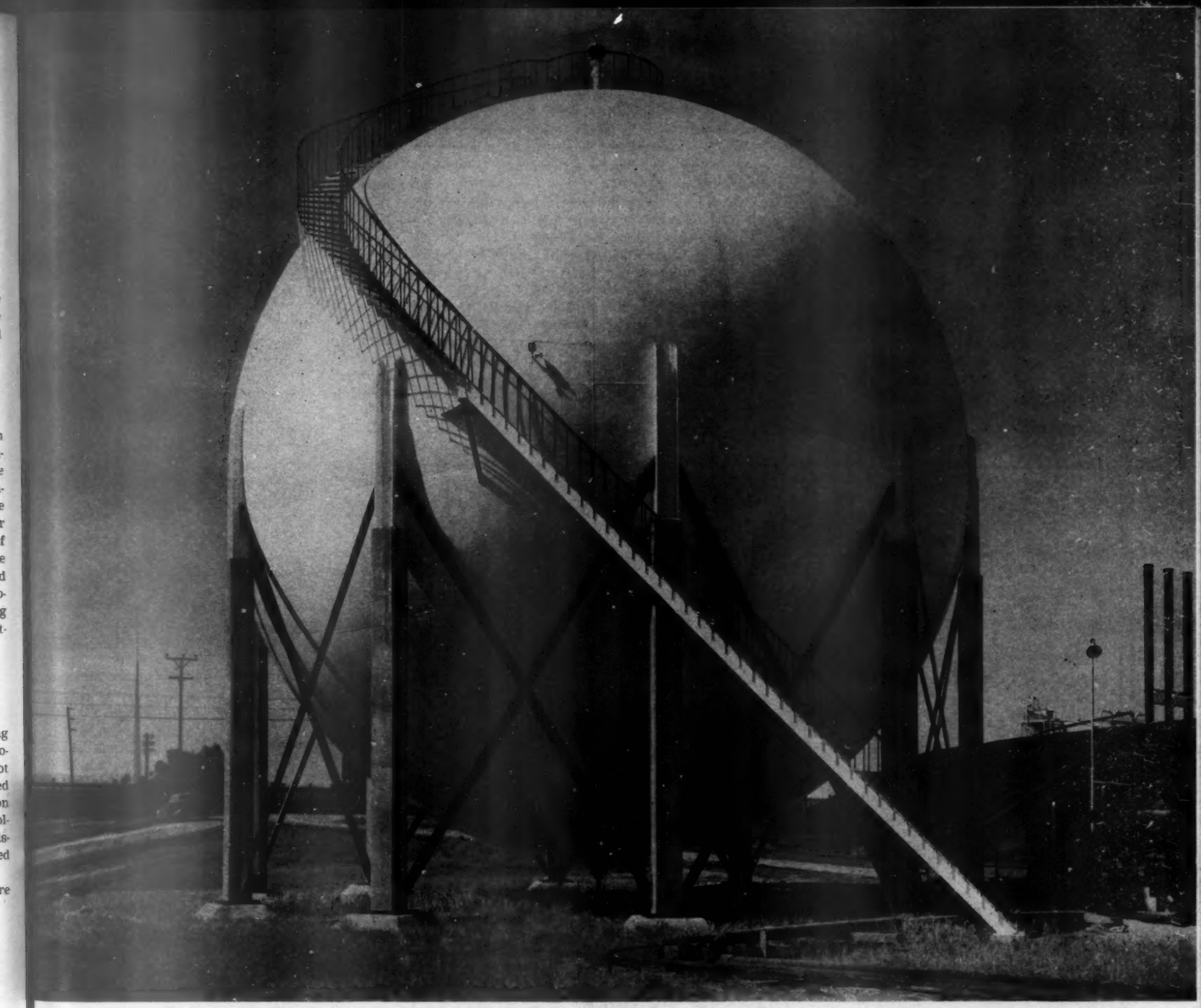
by combining it with ethylene gas, or with alcohol and removing two hydrogen atoms from the ethylbenzene so made.



Ethylene is made by heating ethane from natural gas with or without a catalyst being present, to remove two hydrogen atoms; then by the use of another catalyst such as aluminum chloride the benzene and ethylene unite to form ethylbenzene as shown. Heat and a dehydrogenation catalyst such as used for making butadiene mentioned above removes another pair of hydrogen atoms to yield the required styrene. If alcohol is used instead of ethylene, the alcohol is dehydrated, that is, a molecule of water, H—O—H, is removed which forms ethylene; or a molecule of water is removed from the alcohol and benzene and another hydrogen plus oxygen from the alcohol, combining the two molecules in one step.



followed by removal of two more hydrogen atoms



ON THE *Working Front* with SYNTHETIC RUBBER

JUST what the petroleum industry is doing to aid the nation's synthetic rubber program is, for the most part, a military secret. One fact in this program is well known, however, and that is, the importance of Butadiene in the production of this vital product. This ingredient of synthetic rubber must be protected from deterioration and vapor losses during handling and storage. This protection is also essential in the handling of Butane.

Hortonspheres are helping to maintain a constant supply of Butadiene at synthetic rubber plants, for they prevent volumetric loss by stopping evaporation at its source.

Hortonspheres are widely used for volatile oil products requiring pressures of from 25 to 100 lbs. per sq. in. to prevent evaporation loss. A closed container is essential because gas pressure can build up only in a vapor tight vessel. Thus, the fact that pressure does exist in Hortonspheres proves that no vapor loss is occurring.

Consider Hortonspheres an important link in the manufacture of synthetic rubber.

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HORTONSPHERES

as mentioned above to form styrene, which is identical with that formed from benzene and ethylene. The benzene so used may be obtained by distillation of coal tar, or may be made by cracking—molecular decomposition—of petroleum hydrocarbons at high temperatures. During war emergency more benzene will probably be made by the latter method since the production of coal tar benzene is limited by the amount of coke which may be produced.

These two products, butadiene and styrene, each a very reactive material, are mixed in the proportions of about three parts butadiene to one part styrene, and an emulsion is made in water, using various soaps as the emulsifying agent and requiring only a small percentage (1 per cent or less) of soap. In order to control the progress and nature of the polymerization various other materials are added in small amounts; accelerators which hasten the polymerization; inhibitors which prevent in good measure undesirable reactions; and the entire mass is agitated under somewhat elevated temperature until a white milky mixture results, requiring some hours for completing the reaction. This milky liquid corresponds very closely to the liquid latex taken directly from the rubber tree, the tree having performed the difficult operations of forming the isoprene—instead of the two materials used in synthesis—and of polymerizing it into latex which consists of extremely finely divided particles of crude rubber emulsified in the sap of the tree.

This synthetic latex is then treated with a catalyst, such as an organic acid, vinegar for instance, which coagulates or combines together these small rubber particles into sticky, resilient masses. The resulting mass must be washed with water to remove nonrubber materials, acid, etc., and is dried and rolled into sheets of crude rubber. This completes the essential cycle of synthesizing rubber as we do it today.

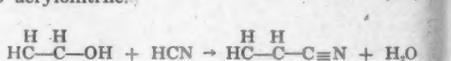
This sheet is milled, that is, run between rolls in large machines, which operation breaks it down somewhat and makes it less stiff and hard. During this milling operation various other chemicals, modifiers, softeners to render it still more pliable and flexible, inhibitors to combat oxidation or aging, metal oxides, sulfur or other vulcanizing agents, along with fillers and other materials such as carbon black, are added.

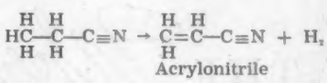
In making tires the form of the tire is built up of cotton or rayon cord and other nonrubber materials; this formed material is impregnated with the rubber heated to make it more in the form of a paste to thoroughly incorporate it into every part of the tire carcass. The whole is placed in a form and heated to several hundred degrees above atmospheric temperature and under pressures of 40 to 50 tons per sq. in. This heat and pressure cause reaction between the rubber molecules and the sulfur or other vulcanizing agent and it is here that the vulcanization of the rubber to the tough flexible but wear-resistant material which we know as finished rubber takes place. Prior to this step the rubber has been a stiff, slightly sticky mass with low tensile strength and poor qualities for its ultimate purpose. Incidentally these final steps are identical in general with those employed with natural rubber. The quantity and chemical composition of the addition agents may vary from those used in natural rubber, but in general the two processes are identical.

This outlines briefly the process by which synthetic tire rubber is made. For specialty rubber which may be oil-resistant and possess other special properties useful for other purposes than tire making butadiene is mixed in proportions of three or four to two or three of a material called acrylonitrile.

Acrylonitrile

Acrylonitrile may be made by combining a molecule each of ethylene and of hydrocyanic (prussic) acid in the form of sodium cyanide, or alcohol may be substituted for the ethylene, forming the acrylonitrile and a molecule of caustic soda, NaOH, afterward dehydrogenating the ethylhitrile to acrylonitrile.

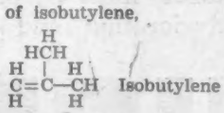




Acrylonitrile

While some of the accessory chemicals differ in part from those employed in making tire (buna-S type) rubber, the essential steps are identical. The raw rubber so produced is later vulcanized and becomes an extremely dense, relatively nonporous material which does not swell measurably in gasoline, lubricating oil, alcohol or other solvent liquids and is especially advantageous for use as insulating material, as impregnant for all types of waterproof fabrics, and innumerable other applications. It is deficient in abrasion (wear) properties and so is not as valuable for tire and similar types of rubber uses as is either natural rubber or the styrene product.

A third type of rubber is butyl, an ersatz or emergency material which has been developed entirely in this country. Its special advantage is the rapidity with which it can be made, and the small percentage of the expensive ingredient, butadiene, required for its synthesis. It is composed of about 2 per cent butadiene and about 98 per cent of isobutylene,



Isobutylene

which is akin to butylene shown in Formula 7.

Anchorgas

Propane and Butanes

for

Synthetic Rubber Plants
Aviation Gasoline
Industrial, Drilling,
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but of slightly differing structure. Methods of preparation of butyl rubber are analogous to those used for other types described here, but simpler in operation. The isobutylene is formed in large quantities in refinery cracking operations, both by thermal methods and especially by catalytic processes, and may be had at relatively low cost, probably less than half the cost of butadiene.

Lower Tensile Strength

Butyl rubber has lower tensile strength than butadiene-styrene or butadiene-acrylonitrile rubber and lower wear quality; it has less "bounce" than either those two or natural rubber. It will be employed to produce emergency tires for less-severe service than that for which the more expensive rubbers are used because it can be produced quickly with a minimum of time for plant construction and operation and at minimum cost. Tire makers expect butyl rubber to go 15,000 to 20,000 miles at speeds of 40 miles per hour or slower. What the fate of butyl rubber will be after the war is won is conjectural, but is is probable that the ever-curious, always-dissatisfied chemist will find specific applications where its peculiar properties will be at a premium for domestic and industrial applications. Butyl rubber is particularly inert to even strong acids which attack any other kind of rubber actively; it "ages" less rapidly than any other rubber, and the effect of water, heat and weather conditions decompose it very slowly. Its sponginess makes it useful for sealing gasoline tanks against bullet perforations in airplanes, since it is swelled rapidly by gasoline, as is natural and buna-S type rubbers. Rubber chemists believe it will have a place in our peacetime economy for various uses which will be developed as time passes.

Because of their more specialized applications other and minor types of synthetic rubber will not be discussed further here. A study of the facts regarding synthetic rubber shows of course that in some properties the synthetic products are superior to natural rubber, in other ways they are inferior. The most valuable fact about rubber synthesis probably is that rubber may be synthesized "to order," that is, various properties may be improved at will, to produce a material which is especially useful for a given purpose, a condition which is true only to a minor degree with natural rubber. Synthetic rubber may be made which is definitely superior to natural rubber in wear qualities, therefore will last longer on the road than will natural-rubber tires. Resilience, that is, stretchability, can be increased far beyond the values of natural rubber in that property, which is a property invaluable in certain applications. These properties can be varied over a wide range of values in synthetic rubber, a fact which will be taken advantage of in the future.

Uses of Synthetic

For example, synthetic rubber has been used in large quantities in the building of motor cars, for gaskets, bushings, insulation and other uses where the specific properties built into the rubber make it much more useful than any other material for these purposes. One large automotive company, at the time the manufacture of motor cars was stopped the first of this year, was using a maximum of 50 tons of synthetic rubber per month in its car and truck output. A similar situation existed in other automotive building companies, and the knowledge developed by American rubber companies in making this product for these purposes and others will prove to be the lifesaver for this country. Without that knowledge this country would be stalled in every direction on automotive transportation, the civilization we know would be arrested, and the war would be irrevocably lost.

One of the primary problems which must be solved by this country after the war is won is that of making ourselves invulnerable by guaranteeing a rubber supply which is not open to easy attack by foreign marauders. On the proper solution of this problem much of our future well being depends. So far as can be seen now, our civilization as we have built it cannot continue without rubber of some type. After food supply, rubber is doubtless the most important product in our national life around which hinges our whole civilization. It will be imperative for the American people to safeguard their civilization by assuring an invulnerable source of rubber safe from attack and which cannot be cut off by other world powers.

Supply of Hydrocarbons Fully Adequate for Emergency Needs

(Continued from Page 37)

butane, isobutylene, and normal butylenes) are or will be in such great demand for the production of aviation gasoline and synthetic-butyl rubber that shortages may develop.

Starting with normal butane as compared with crude oil or gas oil as the charging stock for the manufacture of aviation-fuel agents and synthetic rubber has many advantages that have been overlooked. The favorable factors of speed, critical materials, manpower and over-all economies become quite apparent from a realization of the fact that, except for the final polymerization or alkylation steps, the manufacturing process consists merely in changing normal butane to another C_4 form.

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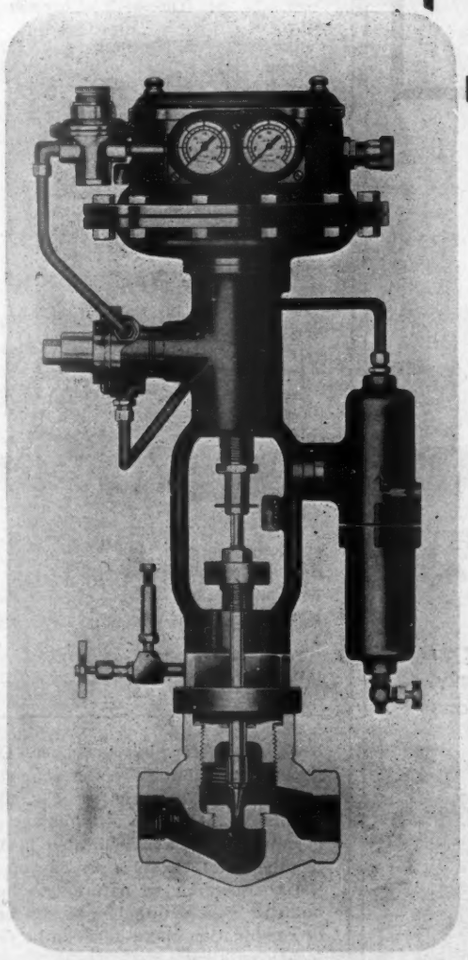

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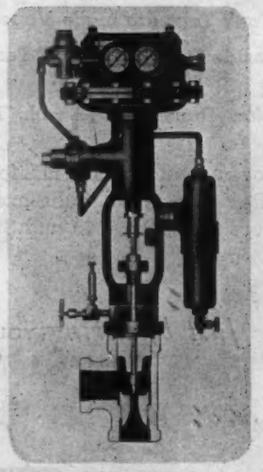
Screwed globe body is forged steel construction for high pressure service. Equipped with needle point inner valve and screwed in renewable seat ring . . . orifice sizes ¼" to ¾". Suitable for initial pressures up to 3000 lbs. at 450° F. Available in body sizes ½" to 2".



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Intended for gas control where extra high pressure drop conditions are encountered. Special forged steel angle type body construction reduces excessive wear on seat ring and aids in the elimination of freezing difficulties. Needle point inner valve and special screwed-in seat ring are hardened or stellite faced as specified. For inlet pressures up to 3000 lbs. at 450° F. Available in sizes 1" to 2". Orifice sizes ¼" to ¾"

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Raw Materials for Synthetic Rubber Intermediates

(Continued from Page 35)

1937, hence under war conditions some of the figures are now doubtless much larger. The benzene production (330,000 gal. per day) is undoubtedly low because it is possible to make more than 3 gal. of benzene for each ton of coal processed—and hence the yield of benzene from coking coal (206,000 tons per day) could exceed 618,000 gal. per day.

The quantities of basic materials required for the rubber program as indicated in Fig. 2, may be compared with Table 1, but conclusions must be based on a careful consideration of many factors, such as other war needs and necessary civilian uses. The only basic stocks that appear to be adequately abundant for supplying the entire rubber program without disturbing other needs or regular markets are mixed butanes, natural gas, petroleum naphtha, and coal. The basic materials that appear to be fundamentally deficient in quantity are benzene and alcohol. It must, however, be borne in mind that many factors enter into such estimates and that the rate of production and the disposition of the basic materials is being drastically altered by the war.

Finally, it must always be remembered that other materials than rubber intermediates are produced in many of the processes. This is notably true of natural gas or gasoline, crude oil, naphtha, and coal. Thus, the processing of crude oil for butadiene, not only yields 710,000 tons of butadiene but may also yield over 100 times as much of other useful products, particularly raw stocks for 100-octane gasoline, toluene, and heavy fuel oil for ships.

The availability of the basic petroleum stocks are indicated in Tables 2, 3, 4, and 5, as well as the approximate amount of mixed butanes normally present in gasoline (Table 4). These tables, along with the raw stock requirements for a 15,000-ton-per-year butadiene plant may be used to judge the situation in any local area. The approximate amounts of basic raw stocks required for a 15,000-ton-per-year butadiene plant are:

Refinery gasoline (9.3% butadiene)	8,600 b.p.d.
Mixed butanes	800 b.p.d. (33,600 gal.)
Natural gasoline	2,430 b.p.d. (101,000 gal.)
Naphtha or gas oil	5,300 b.p.d.
Natural Gas	42,000 M.c.f. per day

The expense and equipment required for producing butane in every natural-gasoline plant would seem to make it advisable to go to petroleum refineries because large amounts of butane are available in even moderate sized refineries. Thus, if a refinery can spare the mixed butanes from 8,600 bbl. per day of gasoline, or a lesser amount, if some natural gasoline or commercial butane can be obtained, he will have enough stock for a butadiene plant and at the same time could supply about 200 bbl. per day of isobutane, a basic stock for butyl rubber. Obviously, the naphtha remaining by the removal of butanes could also be cracked (see Fig. 3), yielding an additional 22,000 tons of butadiene per year. This general operation is indicated in Fig. 3 for the handling of 13,500 bbl. per day of crude oil plus 860 bbl. per day of natural gasoline. It is obvious that a large number of similar modification or combination operations can be devised to meet local conditions.

TABLE 5—CRUDE RUNS TO STILLS (1937)

(Thousands of barrels)

Arkansas	9,172
California	203,145
Colorado	1,227
Georgia	2,662
Illinois	45,626
Indiana	70,585
Kansas	51,515
Kentucky	7,474
Louisiana	66,482
Maryland	13,753
Massachusetts	14,776
Michigan	12,931
Missouri	6,785
Montana	5,253
New Jersey	76,543
New Mexico	1,746
New York:	
East	8,960
West	7,302
Ohio:	
East	11,036
West	27,627
Oklahoma	62,938
Pennsylvania:	
East	81,386
West	18,909
Texas	357,429
Utah	3,166
West Virginia	3,039
Wyoming	11,979
Total United States	1,183,440
Daily average	3,242

Cracking-Still Gases

Much talk has centered about the use of cracking-still gases for the production of rubber stocks, 100-octane fuel, chemicals, etc. It must be recognized, however, that the amount of gases available at any one refinery is too small to supply a major rubber-intermediate plant. The butanes and other useful components of cracked or refinery gas might be concentrated at the refinery and shipped to central plants but this involves large amounts of equipment, the feasibility of which

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Fig. 1640 I.B.B.M.
Fig. 1644 All-Iron
"King-clip" Gate

Fig. 1683 All-Iron
Fig. 1681 I.B.B.M.
Outside Screw
"King-clip" Gate

Fig. 1430
125 lb. S.P.
Iron Body Gate

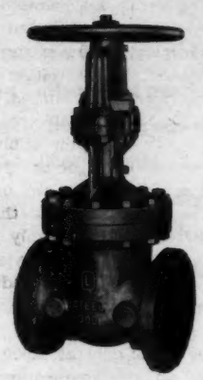

Fig. 1938
300 lb. S.P.
Steel Gate

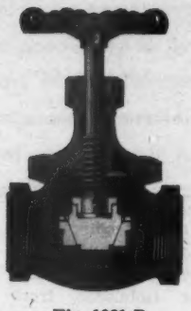

Fig. 1021-P
Plug Type
Iron Body "Ferrenewo"

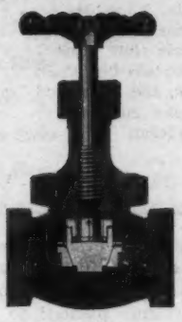

Fig. 16-P 300 lb. S.P.
Fig. 73-P 200 lb. S.P.
Plug Type
Bronze "Renewo"

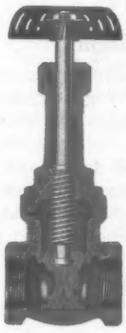

Fig. 2125
125 lb. S.P.
Double Wedge Disc
Bronze Gate

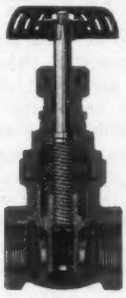

Fig. 2129
125 lb. S.P.
Single Wedge Disc
Bronze Gate

Fig. 427
150 lb. S.P.
Double Wedge Disc
Bronze Gate

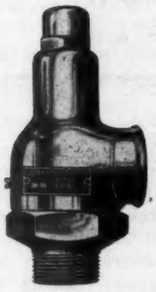

Fig. 1045
Bronze
Pop Valve

Fig. 658
Bronze
Relief Valve

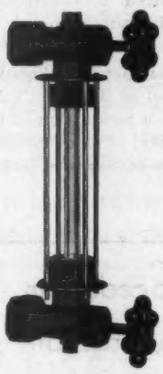

Fig. 1183
All-Iron
Liquid Gauge

Fig. 554
Bronze Regrinding
Swing Check

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TABLE 6—ESTIMATED REFINERY GASES AND GASEOUS BUTANES

	Cracking still M.c.f. per day	Total ref. gas M.c.f. per day	Butanes	Ethylene M.c.f. per day
East Coast	76,000	112,000	11,200	1,520
Appalachian	16,000	24,000	2,400	320
Ind., Ill., Ky., etc.	85,000	125,000	12,500	1,700
Okla., Kans., Mo.	44,000	65,000	6,500	880
Texas Inland	26,000	37,000	3.700	520
Texas Gulf Coast	121,000	178,000	17,800	2,420
Louisiana Gulf Coast	14,000	21,000	2,100	280
Ark. and La. Inland	7,000	10,000	1,000	140
Rocky Mountain	9,500	14,000	1,400	190
California	42,500	63,000	6,300	850
	441,000	649,000	64,900	8,820

cannot be evaluated without a most comprehensive study. In this connection the construction of small sulfuric acid polymerization plants (diisobutylene plants) to recover isobutene from cracked gases at refineries, as undertaken 6 months ago, does not appear to be progressing well. The cost of production is very large (in some instances over 50 cents per gallon) and the amount of equipment required is enormously large compared to the equipment required by more direct processes of making isobutene.

The amount of cracked gas that is being produced in refineries is somewhat as shown in Table 6. These figures are based on a production of 600 cu. ft. of cracked gas per barrel of cracked gasoline, on 300 cu. ft. of other plant vapors per barrel of straightrun gasoline, on a yield of mixed butanes of 4.2 gal. per 1,000 cu. ft. of total gases, and on an ethylene content of 2 per cent in cracked gases.

References

1. Hopkins, M. B., Refiner Nat. Gaso. Mfr., Page 125, Oct. 1942.
2. Hall, E. L., Chem. & Met. Engineering, Page 100, Sept. 1941.
3. U. S. Bureau of Mines, Minerals Yearbook, 1937.
4. Nelson, W. L., The Oil and Gas Journal, Page 10, Jan. 22, 1942.
5. Houdry Officials—Refiner & Nat. Gaso. Mfr., Page 195, Oct. 1942.
6. The World Almanac of 1941.
7. Sixteenth Census of the U. S. Manufacturers. Sugar Subgroup, 1940.

Used Equipment Speeds Sun Butadiene Plant Construction

(Continued from Page 39)

the catalyst deposit to promote the chemical change of butane to butylene in one stage and of butylene to butadiene in the other as well. Final separation and purification of the butadiene may be attained by one of the available purification processes. The estimated costs of producing butadiene from butane, including purification, by this process, in the Gulf Coast or Mid-Continent area, are slightly more than 6 cents per pound. This figure does not include amortization. This estimate, covering electric power, fuel (oil and gas), steam, cooling and makeup water, labor, catalyst, inhibitor, solvent, maintenance, tax, administration, and royalty charges, is $128.42 per ton for a plant with a capacity of 15,000 tons per year.

Semicommercial Butadiene Plant

A semicommercial-size catalytic dehydrogenation plant, believed to be the first in the country designed and constructed primarily for the production of butadiene, has been in operation for the past 5 weeks at a refinery of Sun Oil Co. The unit was built to provide conclusive proof that the Houdry two-stage catalytic dehydrogenation process for the production of butadiene from butane is both a commercially feasible and a practical process for inclusion in the country's synthetic-rubber program.

Butadiene is the major constituent of Buna-S rubber, the type which constitutes the bulk of the program as it is now being pursued. Speed of construction of plants, the availability of material for charging stock and the yield of butadiene from the processing material are important considerations in the evaluation of processes that are available for its production.

The rapid rate of construction indicated as possible for plants using the Houdry catalytic process is due to its relative simplicity and high yields obtained.

Operating temperatures are relatively low so that construction materials and alloy steels are kept to a minimum.

Requirements for utilities, such as steam, fuel, power, and water, are likewise low. Therefore, less material is needed for construction of plants to supply them.

Advantage of Design

The design of these plants permits the extensive use of material either existing at refineries or available as second-hand equipment. This advantage was demonstrated in the semicommercial plant which was designed, built, and put into operation in the remarkably short space of 6 weeks. It went on stream October 23 and has been in continuous operation since. It was built entirely of used equipment available at the refinery, thus avoiding completely the use of any new critical material that would require priorities.

The unit is charging butane at the rate of approximately 120 gal. per hour. An ample supply of butane is available in relatively pure form and its use as charging stock for the dehydrogenation unit does not impair either the production of important aviation gasoline or the production of materials for civilian or industrial consumption as they are produced under existing circumstances.

The laboratory and pilot-plant results have been substantiated in the operation of the semicommercial plant. The burning of the carbon deposit in the course of the process furnishes the major portion of the heat required for the dehydrogenation cycle. It is estimated that the useful life of the catalyst will exceed 6 months.

In Scale and Large Plant

Design of the semicommercial plant is strictly in scale with the large plant now being built at another Sun Oil Co. refinery, and described above. The semicommercial plant is of sufficient size that observations and conclusions based on its operation will be applicable to the operation of the large plant. In addition to providing operating technique and data for the larger unit, this unit will be used to train operators for it.

The substantial size of the semicommercial plant is indicated by the volume of butane, 120 gal. per hour, charged to the first stage. This is approximately one-tenth of the volume which will be charged to the 15,000-ton-per-year plant. A combination of butane and butylene is charged to the second stage at the rate of about 200 gal per hour.

Further appreciation of the size of the plant may be obtained from the accompanying illustrations showing the reactor, the quenching unit, and the vacuum pumps. The reactor is more than 8 ft. in diameter and holds a catalyst bed measuring 6½ ft. across.

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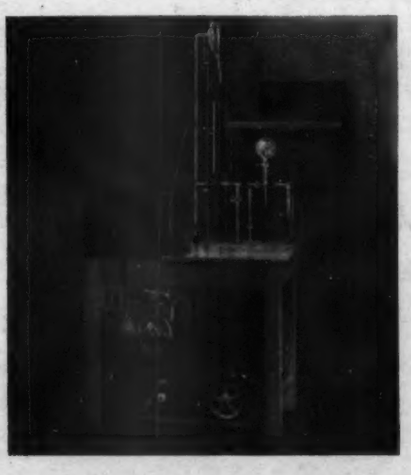

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(Left) The Beckman Automatic pH Indicator is the most advanced pH instrument available today. It operates directly from 115 V. mains and incorporates important advancements available in no other make or type of pH equipment. (For full details, ask for Bulletin 161). (Center) The Beckman Quartz Spectrophotometer speeds all types of research and control work. Covers the full Spectral range of interest in spectrophotometry—220 mmu in the ultraviolet to 1000 mmu in the infrared. Simple to operate, extremely accurate, and ruggedly built for long life, sustained performance. (Right) The Beckman Infrared Spectrophotometer was specially developed for controlling refinery operations by a leading petroleum research laboratory. Simplifies process control and insures maximum recovery in the production of modern aviation gasolines.

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Methods of Preparing Butadiene

This series of articles presents a complete summary of the sources of butadiene as revealed by the technical literature and by the research staff of Universal Oil Products Co. It contains a total of 38 tables of data. A list of the subjects covered was published on Page 41 of the November 5 issue of the Journal.

By GUSTAV EGLOFF and GEORGE HULLA
Universal Oil Products Co., Chicago, Ill.

(PART 4)

Table 8 gives data on thermal treatments of miscellaneous charging stocks yielding butadiene among other products. The processes considered include the passage of natural gas through a chromium steel tube, the exposure of petroleum distillate or cracked gases to a red hot platinum wire, and dry distillations of natural rubber and the "butadiene rubber" secured by action of zinc upon polymeric vinyl bromide. In all cases the butadiene yields are reported on a qualitative rather than quantitative basis.

TABLE 8—THERMAL TREATMENT OF NATURAL GAS, PETROLEUM DISTILLATE OR CRACKED GASES, NATURAL RUBBER, AND "BUTADIENE RUBBER"

Charging stocks	Apparatus used	Temp. (°C.)	Pressure (atm.)	Remarks (B is butadiene-1,3)	References
Persian natural gas (CH_4 to C_6H_{12} inclusive) after hydrogen sulfide removal and 22 per cent addition of nitrogen	26% Cr steel tube	850	1.36	B yield = ?	S. F. Birch and E. N. Hague, Ind. Eng. Chem. 26, 1,008-1,010 (1934).
Petroleum distillation gas or petroleum cracking gas	Pt wire	Red heat		See patent for details.	B. V. Bulzov, Russian Patent 1102 of Sept. 15, 1928; Chem. Abs. 22, 4,132 (1928).
Natural rubber	Cu vessel for dry distillation		1	B was probably present in the product called "Doppelt Kohlenwasserstoff."	A. Bouchardat, Ann. 27, 30-40 (1838); Journal de Pharmacie 23, 454-464 (1837).
Natural rubber	Apparatus for dry distillation	?	?	B yield = ?	I. I. Ostromyslenskii, "Kauchuk i Ego Analogi," Moscow (1913); Translation S-201A in July 24, 1942 Universal Oil Products Co. Survey of Foreign Petroleum Literature, Page 51.
"Butadiene rubber" from cauprene bromide and zinc	Apparatus for dry distillation	?	?	B yield = "Cauprene bromide" is synonymous with polymeric vinyl bromide.	I. I. Ostromyslenskii, "Kauchuk i Ego Analogi," Moscow (1913); Translation S-201A in July 24, 1942 Universal Oil Products Co. Survey of Foreign Petroleum Literature, Page 51.

Table 9 lists hydrocarbons yielding butadiene under the influence of cracking catalysts and elevated temperatures. Cyclohexane and cyclohexene gave the greatest yields in this group (the theoretical yields of butadiene from these hydrocarbons are 64.4 and 65.9 per cent by weight, respectively). Gasolines containing cyclohexanes, therefore, should be desirable stocks for catalytic cracking into butadiene plus alkenes. The mineral yields from *n*-butenes are to be expected, since the reported process was designed for selective chain splitting, including isomerization into 2-methylpropene. The catalytic cracking of *n*-butenes should not be confounded with catalytic dehydrogenation of the same alkenes.

TABLE 9—CATALYTIC CRACKING OF HYDROCARBONS

Hydrocarbons		Catalyst	Temp. (°C.)	Pressure (atm.)	Remarks (B is butadiene-1,3)	References
2-Methylbutane	$C_5H_{12} \rightarrow C_4H_6 + CH_4 + H_2$	Silica gel	680	1	B yield = ?	A. Hailhe and Creusot, Comp. rend 194, 2,220-2,222 (1932).
n Butenes		Silica + alumina	385-600	1	B yields were 0.5, 0.2, 0.3, .0.3 and 0.8% by weight on hydrocarbon feed at 400°, 450°, 500°, 550° and 600° C., respectively.	G. Egloff, J. C. Morrell, C. L. Thomas, and H. S. Bloch, J. Am. Chem. Soc. 61, 3,571-3,580 (1939).
Cyclohexane in presence of steam	$C_6H_{12} \rightarrow C_4H_6 + C_2H_4 + H_2$	Calcium oxide	680	1	B yield was 41% by weight on absolute cyclohexane.	I. G. Farbenindustrie A.-G., German Patent 533,778 of May 7, 1931; Friedlaender's Fortschritte der Teerfarbenfabrikation 18, 754-756 (1933).
Cyclohexene in presence of steam	$C_6H_{10} \rightarrow C_4H_6 + C_2H_4$	Magnesium oxide	680	1	B yield was 22.4% by weight on absolute cyclohexene per pass, calculating to 56% by weight on fully decomposed cyclohexene.	I. G. Farbenindustrie A.-G., German Patent 533,778 of May 7, 1931; Friedlaender's Fortschritte der Teerfarbenfabrikation 18, 754-756 (1933).
Benzine (boiling range 60°-150° C.) in presence of steam		Graphite in an iron + nickel + chromium tube lined with copper + manganese alloy	740	1	B yield = ?	I. G. Farbenindustrie A.-G., German Patent 533,778 of May 7, 1931; Friedlaender's Fortschritte der Teerfarbenfabrikation 18, 754-756 (1933).
Benzine (from pressure hydrogenation of brown coal) in presence of steam		Lustrous carbon deposited on silica gel	720	1	B yield was 16% by weight on fully decomposed benzine.	I. G. Farbenindustrie A.-G. (O. Schmidt, M. Treppenhauer, O. Grosskinsky, and H. Fischer, inventors, German Patent 565,159 of Nov. 29, 1927.
American illuminating petroleum (kerosene?) in presence of steam		Lustrous carbon deposited on magnesium oxide	700	1	B yield was 12% by weight on fully decomposed petroleum	I. G. Farbenindustrie A.-G. (O. Schmidt, M. Treppenhauer, O. Grosskinsky, and H. Fischer, inventors, German Patent 565,159 of Nov. 29, 1927.

(Continued on next page)

Three facts for refiners—

Refiners building or re-building plants for the production of synthetic rubber ingredients should know these facts:

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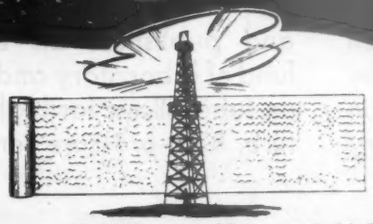

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TABLE 9—CATALYTIC CRACKING OF HYDROCARBONS (Continued)

Hydrocarbons	Catalyst	Temp. (°C.)	Pressure (atm.)	Remarks (B is butadiene-1,3)	References
Benzine (boiling range 65°-75° C.; from destructive hydrogenation of coal)	Quartz or platinum	Red heat	1 (?)	B yield = ?	C. Krauch and M. Muller-Sunradi (assignors to I. G. Farbenindustrie A.-G.), U. S. Patent 1,823,495 of Sept. 15, 1931.
Gas oil (boiling range 230°-400° C.; sp. gr. 0.86 at 15° C.) in presence of steam	Lustrous carbon on magnesium oxide	720-730	1	B yield was 7% by weight on gas oil feed	I. G. Farbenindustrie A.-G. (O. Schmidt, M. Treppenhauer, O. Grosskinsky, and H. Fischer, inventors), German Patent 565,159 of Nov. 29, 1927.
Gas oil (boiling range 200°-380° C.) in presence of steam	Graphite	760-780	1	B yield = ?	I. G. Farbenindustrie A.-G., German Patent 533,778 of May 7, 1931; Friedlaender's Fortschritte der Teerfarbenfabrikation 18, 754-756 (1933).

Table 10 covers electrical treatment of hydrocarbons, including alkanes, ethene, and ethyne. The yields of butadiene-1,3 for the several types of electrical apparatus are obviously small and expensive. The proceesses are trebly costly due to the expensive current, the low yields per pass and number of recyclings.

TABLE 10—ELECTRICAL TREATMENT OF HYDROCARBONS

Hydrocarbons		Apparatus used	Temp. (°C.)	Pressure (atm.)	Remarks (B is butadiene-1,3)	References
Methane	$4\,CH_4 \rightarrow C_4H_6 + 5\,H_2$	Electric arc	High	?	Reaction is not stoichiometrical.	H. Tanneberger, Ber. 66, 484-486 (1933).
n-Hexane, *n*-heptane, *n*-octane, *n*-decane, or kerosene	$C_6H_{14} \rightarrow C_4H_6 + C_2H_2 + 3\,H_2$ $C_{10}H_{22} \rightarrow 2\,C_4H_6 + C_2H_2 + 4\,H_2$	Electric arc with Cu or Fe electrodes in vapor space but kept wet by the refluxing hydrocarbon. Used 3-4.5 amp. at 60-80 volts.		1	B yields = ?	C. L. Pacella Heylen, Rev. facultad quim. ind. agr. (Univ. nacl. litoral, Santa Fe, Argentina) 6, 126-132 (1937) (publ. 1938); Chem. Abs. 32, 6,446-6,447 (1938).
Ethene	$2\,C_2H_4 \rightarrow C_4H_6 + H_2$	Silent electrical discharge			See original article for details.	W. Szukiewicz, Roczyniki Chem. 13, 245-255 (in English, 255) (1933); Chem. Abs. 27, 4,487 (1933); Chem. Zentr. 104, 1,499 (1933).
Ethene	$2\,C_2H_4 \rightarrow C_4H_6 + H_2$	Spark discharge between Cu electrodes (8 cm. apart, 60 watts)	High	1 (?)	B yields was 8.05% by weight on exit gas after 4 passes.	P. Feiler (assignor to I. G. Farbenindustrie A.-G.), U. S. Patent 1,799,787 of April 7, 1931.
Ethene	$2\,C_2H_4 \rightarrow C_4H_6 + H_2$	Spark discharge between carbon electrodes (200 watts)	High	1 (?)	B yield was 3.7% by weight on exit gas.	P. Feiler (assignor to I. G. Farbenindustrie A.-G.), U. S. Patent 1,799,787 of April 7, 1931.
Ethene + hydrogen mixture	$2\,C_2H_4 \rightarrow C_4H_6 + H_2$	High frequency discharge (15,000 volts and 5-8 watts output)		1	B yields were 1.7%, 4.1%, 6.4% and 2.6% by weight on fully decomposed absolute ethene for feed containing 41.9%, 60%, 70%, and 91.8% of ethene, respectively.	A. A. Balandin, J. T. Eidus, and N. G. Zalogin, Compt. rend. acad. sci. U.R.S.S. 4, 132-135 (in German, 135-137) (1934).
Ethyne		Corona discharge of high frequency (385 meters and 30,000 volts)		About 1	B yield was 0.3% by weight on feed. Circulation time was 0.75 hour.	A. A. Balandin, J. T. Eidus, and E. M. Terentjeva, Compt. rend. acad. sci. U.R.S.S. 27, 343-348 (1940).
Ethyne in presence of hydrochloric acid		Corona discharge of high frequency (385 meters and 30,000 volts). Electrodes were wetted with concentrated hydrochloric acid		About 1	B yield was 0.4% by weight on absolute ethyne feed. Circulation time was 4 hours.	A. A. Balandin, J. T. Eidus, and E. M. Terentjeva, Compt. rend. acad. sci. U.R.S.S. 27, 343-348 (1940).
Ethyne in presence of hydrogen and some nitrogen		Corona discharge of high frequency (385 meters and 30,000 volts)		About 1	B yield was 0.49% by weight on absolute ethyne feed for circulation time of 1.5 hours, and 0.7% by weight on fully decomposed ethyne.	A. A. Balandin, J. T. Eidus, and E. M. Terentjeva, Compt. rend. acad. sci. U.R.S.S. 27, 343-348 (1940).
Ethene + ethyne + nitrogen mixtures		Corona discharge of high frequency (385 meters and 30,000 volts)		About 1	B yields were 1.2%, 2.0%, and 2.6% by weight on "fully decomposed" absolute ethene + ethyne for circulation times of 0.6, 0.9, and 1.0 hour, respectively.	A. A. Balandin, J. T. Eidus, and E. M. Terentjeva, Compt. rend. acad. sci. U.R.S.S. 27, 343-348 (1940).
Ethene + ethyne + hydrogen + nitrogen mixtures		Corona discharge of high frequency (385 meters and 30,000 volts)		About 1	B yield was 1.7% by weight on "fully decomposed" absolute ethene + ethyne. Circulation time was 3 hours.	A. A. Balandin, J. T. Eidus, and E. M. Terentjeva, Compt. rend. acad. sci. U.R.S.S. 27, 343-348 (1940).

Table 11 is concerned with the catalytic isomerization of butadiene-1,2, butyne-1, butyne-2, methylenecyclopropane, and 1-methylcyclopropene-1 into butadiene-1,3. In several cases the yields are unknown or low. In such instances, the choice of catalyst and/or reaction conditions may be questioned and improved upon. Theoretically, the use of a catalyst devoid of side-reaction tendencies, in conjunction with fractionation and recycling of the "isomerizate" or product, should lead to butadiene-1,3 yields approaching the amount of isomer used as starting material. These isomerizations constitute a challenge to the organic chemist interested in new approaches toward the "butadiene rubber" goal.

TABLE 11—ISOMERIZATION OF HYDROCARBONS

Hydrocarbons		Catalyst	Temp. (°C.)	Pressure (atm.)	Remarks (B is butadiene-1,3)	References
Butadiene-1,2	$H_2C{=}C{=}CH{\cdot}CH_3 \rightarrow H_2C{=}CH{\cdot}CH{=}CH_2$	Floridin	330	1	B yield was 15.5% by weight on feed, calculating to 35.7% by weight on fully decomposed feed.	Ya. M. Slobodin, J. Gen. Chem. (U.S.S.R.) 5, 48-52 (1935); Translation S-203 in July 31, 1942, Universal Oil Products Co. Survey of Foreign Petroleum Literature.
Butyne-1	$HC{\equiv}C{\cdot}CH_2{\cdot}CH_3 \rightarrow H_2C{=}CH{\cdot}CH{=}CH_2$	Pumice	300		B yield = ? This isomerization is the next to last step in the De Boistesselin and Dubosc rubber-substitute process which involves the steps $C_2H_2 \rightarrow CH_3CHO \rightarrow CH_4 + CO \rightarrow 2\,CH_4 \rightarrow C_2H_4 + C_2H_6 \rightarrow$ (add C_2H_2) butyne-1 plus pentyne-1 → butadiene-1,3 plus 2-methylbutadiene-1,3 → rubber substitute.	A. Dubosc and A. Littringer, "Rubber," C. Griffin & Co., Ltd., London (1918), p. 253; cf. A. Dubosc, Caoutchouc and gutta-percha 9, 6,706-6,713 (1912).
Butyne-1	$HC{\equiv}C{\cdot}CH_2{\cdot}CH_3 \rightarrow H_2C{=}CH{\cdot}CH{=}CH_2$	Magnesium oxide	460	0.0461	B yield was "good." Other products (butyne-1 and butyne-2) are recycled. Instead of vacuo can use nitrogen as diluent.	I. G. Farbenindustrie A.-G., British Patent 507,847 of June 20, 1939.
Butyne-2	$H_3C{\cdot}C{\equiv}C{\cdot}CH_3 \rightarrow H_2C{=}CH{\cdot}CH{=}CH_2$	Aluminum oxide	450-500	0.0263-0.0526	B yield = ?	I. G. Farbenindustrie A.-G., British Patent 507,847 of June 20, 1939.
Butyne-2	$H_3C{\cdot}C{\equiv}C{\cdot}CH_3 \rightarrow H_2C{=}CH{\cdot}CH{=}CH_2$	Magnesium oxide	460 (?)	0.0461 (?)	B yield was about 50% by weight on feed per pass and 95% by weight on recycling. Instead of vacuo can use nitrogen as diluent.	I. G. Farbenindustrie A.-G., British Patent 507,847 of June 20, 1939.
Butyne-2 in the presence of carbon dioxide	$H_3C{\cdot}C{\equiv}C{\cdot}CH_3 \rightarrow H_2C{=}CH{\cdot}CH{=}CH_2$	Potassium hydroxide	350-400	1	B yield on recycling was "excellent." Can use other alkalies, alkaline earths, or mixtures of same in place of KOH. Can use steam, steam plus carbon dioxide, or reduced pressure instead of carbon dioxide.	I. G. Farbenindustrie A.-G., British Patent 507,847 of June 20, 1939.
Methylenecyclopropane	$H_2C{-}C{=}CH_2 \rightarrow H_2C{=}CH{\cdot}CH{=}CH_2$ (C, H_2)	Aluminum oxide	350		B yield = ?	B. K. Mereshkovskii, J. Russ. Phys.-Chem. Soc. 45, 2,071-2,072 (1913).
1-Methylcyclopropene-1	$HC{=}C{\cdot}CH_3 \rightarrow H_2C{=}CH{\cdot}CH{=}CH_2$ (C, H_2)	Aluminum oxide	325		B yield = ?	B. K. Mereshkovskii, J. Russ. Phys.-Chem. Soc. 46, 97-123, (1914).

Table 12 presents data on the hydrogenation of butenyne ($H_2C{=}CH{\cdot}C{\equiv}CH$) and butadiyne ($HC{\equiv}C{\cdot}C{\equiv}CH$) by (*A*) hydrogen gas in the presence of active metal catalysts, (*B*) acidified solutions of chromous chloride or sulfate, and (*C*) zinc dust plus solutions of various alkalies. Judging from the data for butenyne in the presence of hydrogen gas, hydrogenation in the presence of an ethyl acetate or acetone phase gives better results than without these solvents. This phenomenon probably applies to the corresponding hydrogenation of butadiyne. The butadiene yields in the reductions employing chromous salts or zinc plus alkali are high, approaching quantitative values on recycling at room temperatures. Hydrogenations of butenyne and butadiyne establish a connection between ethyne, which is the source of hydrocarbons, and butadiene-1,3.

TABLE 12—HYDROGENATION OF BUTENYNE AND BUTADIYNE

Processes	Catalyst or reactants	Temp. (°C.)	Pressure (atm.)	Remarks (B is butadiene-1,3)	References
Hydrogenation of butenyne by hydrogen gas $C_4H_4 + H_2 \rightarrow C_4H_6$	Palladium + kieselguhr (1:1028)	80	1?	B yield was 35.0% by weight on absolute butenyne feed and 38.3% by weight on fully decomposed butyene. Other tests showed lower yields on absolute butenyne feed	Z. Hurukawa and K. Nakaguti, J. Soc. Chem. Ind. Japan 43, Suppl. binding 142-144 (1940); Rubber Chem. Tech. 13, 856 (1940)
Hydrogenation of butenyne by hydrogen gas $C_4H_4 + H_2 \rightarrow C_4H_6$	Palladium + iron + kieselguhr (1:100:100)	122-125	1?	B yield was 26.1% by weight on absolute butenyne feed and 28.7% by weight on fully decomposed butenyne. Other tests showed lower yields on absolute butenyne feed	Z. Hurukawa and K. Nakaguti, J. Soc. Chem. Ind. Japan 43, Suppl. binding 142-144 (1940); Rubber Chem. Tech. 13, 856 (1940)
Hydrogenation of butenyne by hydrogen gas $C_4H_4 + H_2 \rightarrow C_4H_6$	Palladium + nickel + kieselguhr (1:5:1000)	58	1?	B yield was 15.3 by weight on absolute butenyne feed and 22.0% by weight on fully decomposed butenyne. Other tests showed lower yields on absolute butenyne feed	Z. Hurukawa and K. Nakaguti, J. Soc. Chem. Ind. Japan 43, Suppl. binding 142-144 (1940); Rubber Chem. Tech. 13, 856 (1940)
Hydrogenation of butenyne by hydrogen gas $C_4H_4 + H_2 \rightarrow C_4H_6$	Nickel + kieselguhr (1:50)	150	1?	B yield was 3.3% by weight on absolute butenyne feed and 5.08% by weight on fully decomposed butenyne	Z. Hurukawa and K. Nakaguti, J. Soc. Chem. Ind. Japan 43, Suppl. binding 142-144 (1940); Rubber Chem. Tech. 13, 856 (1940)
Hydrogenation of butenyne by hydrogen gas $C_4H_4 + H_2 \rightarrow C_4H_6$	Cobalt + kieselguhr (1:1)	80-90	1?	B yield was 4.9% by weight on absolute butenyne feed and 10% by weight on fully decomposed butenyne	Z. Hurukawa and K. Nakaguti, J. Soc. Chem. Ind. Japan 43, Suppl. binding 142-144 (1940); Rubber Chem. Tech. 13, 856 (1940)

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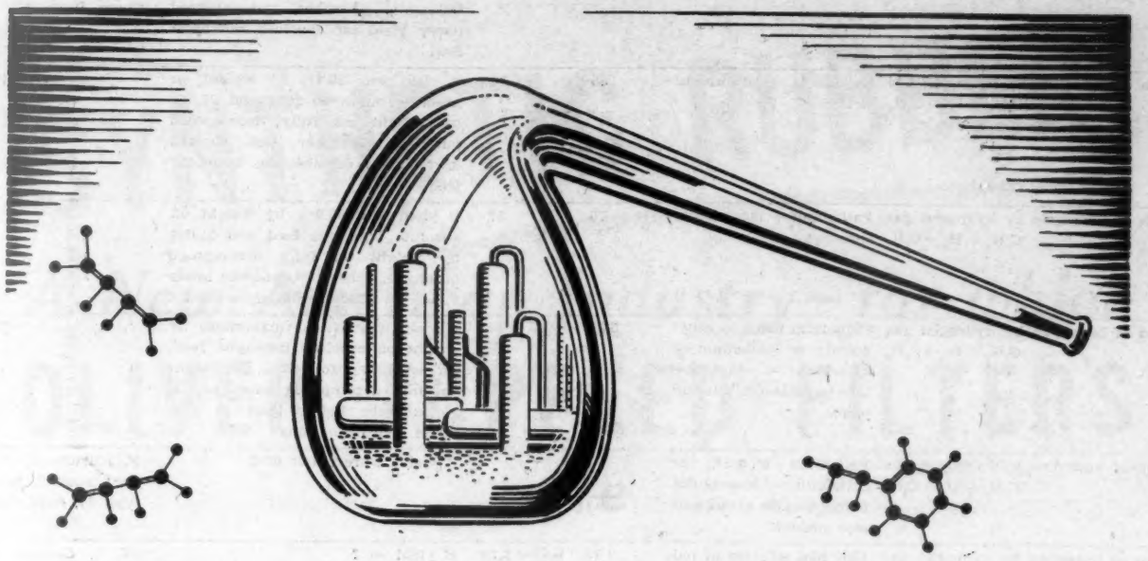

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BUTENE
BUTADIENE

to

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TABLE 12—HYDROGENATION OF BUTENYNE AND BUTADIYNE (Continued)

Processes	Catalyst or reactants	Temp. (°C.)	Pressure (atm.)	Remarks (B is butadiene-1,3)	References
Hydrogenation of butenyne by hydrogen gas $C_4H_4 + H_2 \rightarrow C_4H_6$	Iron + kieselguhr (1:1)	200	1?	B yield was 7.5% by weight on absolute butenyne feed and 32% by weight on fully decomposed butenyne. Another test showed lower yield on absolute butenyne feed	Z. Hurukawa and K. Nakaguti, J. Soc. Chem. Ind. Japan 43, Suppl. binding 142-144 (1940); Rubber Chem. Tech. 13, 856 (1940)
Hydrogenation of butenyne by hydrogen gas $C_4H_4 + H_2 \rightarrow C_4H_6$	Palladium + aluminum (1:100)	85	1?	B yield was 20.4% by weight on absolute butenyne feed and 27.5% by weight on fully decomposed butenyne. Another test showed lower yield on absolute butenyne feed	Ibid.
Hydrogenation of butenyne by hydrogen gas $C_4H_4 + H_2 \rightarrow C_4H_6$	Palladium + magnesium turnings	70	1?	B yield was 33.9% by weight on absolute butenyne feed and 51.0% by weight on fully decomposed butenyne. Other tests showed lower yields on absolute butenyne feed	Ibid.
Hydrogenation of butenyne by hydrogen gas $C_4H_4 + H_2 \rightarrow C_4H_6$	Palladium black + ethyl acetate or palladium + kieselguhr + ethyl acetate to establish a liquid phase	5-20	1?	B yield was 57.1% (maximum) by weight on absolute butenyne feed, corresponding to 64.2% by weight on fully decomposed butenyne. B yields were better than in gas-phase hydrogenations	Ibid.
Hydrogenation of butenyne by hydrogen gas $C_4H_4 + H_2 \rightarrow C_4H_6$	Palladium black or palladium + kieselguhr. Ethyl acetate or acetone also present			B yields were about 60%	Z. Hurukawa, J. Electrochem. Assoc. Japan 7, 346-353 (1939); Chem. Abs. 34, 6482 (1940).
Hydrogenation of butenyne by hydrogen gas $C_4H_4 + H_2 \rightarrow C_4H_6$	Colloidal solution of palladium in water	1-15	Below 2.72	B yield = ?	W. S. Calcott, A. S. Carter, and F. B. Downing (assignors to E. I. du Pont de Nemours & Co.), U. S. Patent 1,920,242 of Aug. 1, 1933
Hydrogenation of butenyne by hydrogen gas $C_4H_4 + H_2 \rightarrow C_4H_6$	Colloidal solution of palladium in water containing 25-50% of ethanol	1-15	Below 2.72	B yield = ?	Ibid.
Hydrogenation of butenyne by hydrogen gas $C_4H_4 + H_2 \rightarrow C_4H_6$	Reduced nickel prepared from the nitrate	40-100	Below 1.02	B yield = ? Unconverted material may be recycled	Ibid.
Hydrogenation of butenyne by hydrogen gas $C_4H_4 + H_2 \rightarrow C_4H_6$	Reduced nickel prepared from the oxalate	40-100	Below 1.02	B yield = ?	Ibid.
Hydrogenation of butenyne by hydrogen gas $C_4H_4 + H_2 \rightarrow C_4H_6$	Reduced cobalt + kieselguhr	40-100	Below 1.02	B yield = ?	Ibid.
Hydrogenation of butenyne by hydrogen gas $C_4H_4 + H_2 \rightarrow C_4H_6$	Reduced nickel chromate	40-100	Below 1.02	B yield = ?	Ibid.
Hydrogenation of butenyne by hydrogen gas $C_4H_4 + H_2 \rightarrow C_4H_6$	Reducible platinum oxide containing ethanol	−10 to +40	2.72-6.80	B yield = ?	Ibid.
Hydrogenation of butenyne by hydrogen gas $C_4H_4 + H_2 \rightarrow C_4H_6$	Reducible platinum oxide containing acetic acid	−10 to +40	2.72-6.80	B yield = ?	Ibid.
Hydrogenation of butenyne by hydrogen gas $C_4H_4 + H_2 \rightarrow C_4H_6$	Reducible platinum oxide containing decahydronaphthalene	−10 to +40	2.72-6.80	B yield = ?	Ibid.
Hydrogenation of butenyne by hydrogen gas $C_4H_4 + H_2 \rightarrow C_4H_6$	Reducible platinum oxide containing decahydronaphthalene	50-80	0-1.02	B yield = ? Unconverted material may be recycled	Ibid.
Hydrogenation of butenyne by hydrogen gas $C_4H_4 + H_2 \rightarrow C_4H_6$	Palladium on clay fragments; or palladium black. Oily byproduct was used in the reaction zone also	20-25	1	B yield = ?	W. Berndt and O. Wulff (assignors to I.G. Farbenindustrie A.-G.), U. S. Patent 2,145,387 of Jan. 31, 1939
Hydrogenation of butenyne in acid solution $C_4H_4 + 2CrSO_4 + H_2SO_4 \rightarrow C_4H_6 + Cr_2(SO_4)_3$	Aqueous solution of chromous sulfate containing free sulfuric acid	25	1	B yield on recycling was "practically quantitative"	I.G. Farbenindustrie A.-G., British Patent 486,094 of May 30, 1938
Hydrogenation of butenyne in alkaline solution, $C_4H_4 + Zn + 2OH(ions) \rightarrow C_4H_6 + ZnO_2$ (ion or group)				B yield was over 95%	Z. Hurukawa, J. Electrochem. Assoc. Japan 7, 346-353 (1939); Chem. Abs. 34, 6482 (1940)
Hydrogenation of butenyne in alkaline solution, $C_4H_4 + Zn + 2OH(ions) \rightarrow C_4H_6 + ZnO_2$ (ion or group)	Zinc dust, iron powder, and sodium hydroxide solution	Ordinary	1	B yield = ?	W. Reppe, A. Rothhaas, O. Schmidt, and R. Luehdemann (assignors to Jasco, Inc.), U. S. Patent 2,207,070 of July 9, 1940 [This patent is now vested in L. T. Crowley, Alien Property Custodian; Federal Register 7, No. 62, 2417-2424 (1942)]; I.G. Farbenindustrie A.-G., French Patent 834,111 of Nov. 14, 1938
Hydrogenation of butenyne in alkaline solution, $C_4H_4 + Zn + 2OH(ions) \rightarrow C_4H_6 + ZnO_2$ (ion or group)	Zinc dust, sodium butylnaphthalenesulfonate, and sodium hydroxide solution	20	1	B yield = ?	Ibid.

Continued on Page 134)

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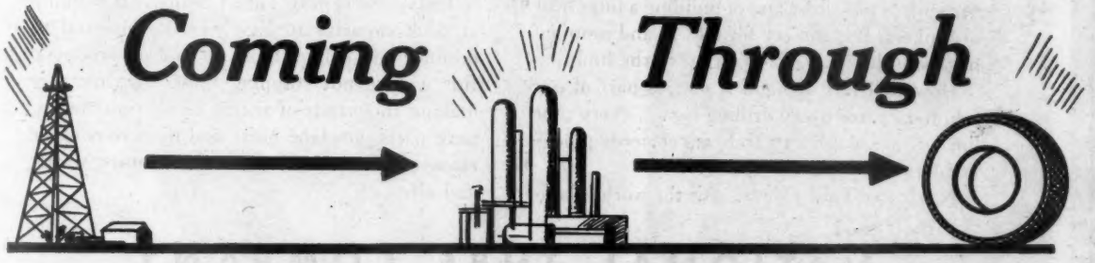

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TABLE 12—HYDROGENATION OF BUTENYNE AND BUTADIYNE (Continued)

Processes	Catalyst or reactants	Temp. (°C.)	Pressure (atm.)	References	Remarks (B is butadiene-1,3)
Hydrogenation of butenyne in alkaline solution, $C_4H_4+Zn+2OH(ions)\rightarrow C_4H_6+ZnO_2$ (ion or group)	Zinc dust, powdered iron, sodium butylnaphthalenesulfonate, calcum hydroxide and water	Ordinary	1	B yield = ?	W. Reppe, A. Rothhaas, O. Schmidt, and R. Luehdemann (assignors to Jasco, Inc.), U. S. Patent 2,207,070 of July 9, 1940 [This patent is now vested in L. T. Crowley, Alien Property Custodian; Federal Register 7, No. 62, 2417-2424 (1942)]; I.G. Farbenindustrie A.-G., French Patent 834,111 of Nov. 14, 1938
Hydrogenation of butenyne in alkaline solution, $C_4H_4+Zn+2OH(ions)\rightarrow C_4H_6+ZnO_2$ (ion or group)	Zinc dust, copper powder, sodium butylnaphthalenesulfonate and sodium hydroxide solution	20	1	B yield = ?	Ibid.
Hydrogenation of butenyne in alkaline solution, $C_4H_4+Zn+2OH(ions)\rightarrow C_4H_6+ZnO_2$ (ion or group)	Zinc dust, manganese powder, and potassium hydroxide solution	20	1	B yield = ?	Ibid.
Hydrogenation of butenyne in alkaline solution, $C_4H_4+Zn+2OH(ions)\rightarrow C_4H_6+ZnO_2$ (ion or group)	Zinc dust, cobalt powder, and sodium hydroxide solution	20	1	B yield = ?	Ibid.
Hydrogenation of butenyne in alkaline solution, $C_4H_4+Zn+2OH(ions)\rightarrow C_4H_6+ZnO_2$ (ion or group)	Zinc dust, iron powder, sodium butylnaphthalenesulfonate, magnesium oxide, and water	Ordinary	1	B yield = ?	Ibid.
Hydrogenation of butenyne in alkaline solution, $C_4H_4+Zn+2OH(ions)\rightarrow C_4H_6+ZnO_2$ (ion or group)	Zinc dust, the oleyl alcohol-ethylene oxide condensation product, ethylamine, and water	Ordinary	1	B yield was "almost quantitative"	W. Reppe and A. Rothhaas (assignors to Jasco, Inc.), U. S. Patent 2,207,071 of July 9, 1940. This patent is now vested in L. T. Crowley, Alien Property Custodian; Federal Register 7, No. 62, 2417-2424 (1942)
Hydrogenation of butenyne in alkaline solution, $C_4H_4+Zn+2OH(ions)\rightarrow C_4H_6+ZnO_2$ (ion or group)	Zinc dust, water, and diethylamine	Ordinary	1	B yield was "almost quantitative"	Ibid.
Hydrogenation of butenyne in alkaline solution, $C_4H_4+Zn+2OH(ions)\rightarrow C_4H_6+ZnO_2$ (ion or group)	Zinc dust, water, and butylamine	Ordinary	1	B yield was "almost quantitative"	Ibid.
Hydrogenation of butenyne in alkaline solution, $C_4H_4+Zn+2OH(ions)\rightarrow C_4H_6+ZnO_2$ (ion or group)	Zinc dust, water, and dibutylamine	Ordinary	1	B yield was "almost quantitative"	Ibid.
Hydrogenation of butenyne in alkaline solution, $C_4H_4+Zn+2OH(ions)\rightarrow C_4H_6+ZnO_2$ (ion or group)	Zinc dust, water, and piperidine	Ordinary	1	B yield was "almost quantitative"	Ibid.
Hydrogenation of butenyne in alkaline solution, $C_4H_4+Zn+2OH(ions)\rightarrow C_4H_6+ZnO_2$ (ion or group)	Zinc dust, water, and ethanolamine	Ordinary	1	B yield was "almost quantitative"	Ibid.
Hydrogenation of butenyne in alkaline solution, $C_4H_4+Zn+2OH(ions)\rightarrow C_4H_6+ZnO_2$ (ion or group)	Zinc dust, water, and diethanolamine	Ordinary	1	B yield was "almost quantitative"	Ibid.
Hydrogenation of butanyne in alkaline solution, $C_4H_4+Zn+2OH(ions)\rightarrow C_4H_6+ZnO_2$ (ion or group)	Zinc dust, water, and triethanolamine	Ordinary	1	B yield was "almost quantitative"	Ibid.
Hydrogenation of butenyne in alkaline solution, $C_4H_4+Zn+2OH(ions)\rightarrow C_4H_6+ZnO_2$ (ion or group)	Zinc dust, water, and pyridine	Ordinary	1	B yield was "almost quantitative"	Ibid.
Hydrogenation of butenyne in alkaline solution, $C_4H_4+Zn+2OH(ions)\rightarrow C_4H_6+ZnO_2$ (ion or group)	Zinc dust, water, and hydrazine hydrate	Ordinary	1	B yield was "almost quantitative"	Ibid.
Hydrogenation of butenyne in alkaline solution, $C_4H_4+Zn+2OH(ions)\rightarrow C_4H_6+ZnO_2$ (ion or group)	Zinc dust, water, and tetramethylammonium hydroxide	Ordinary	1	B yield was "almost quantitative"	Ibid.
Hydrogenation of butenyne in alkaline solution, $C_4H_4+Zn+2OH(ions)\rightarrow C_4H_6+ZnO_2$ (ion or group)	Zinc dust, water, and aniline	Ordinary	1	B yield was "almost quantitative"	Ibid.
Hydrogenation of butenyne in alkaline solution, $C_4H_4+Zn+2OH(ions)\rightarrow C_4H_6+ZnO_2$ (ion or group)	Zinc dust, sodium butylnaphthalenesulfonate, and 5% ammonia solution	Ordinary	1	B yield = ?	Ibid.
Hydrogenation of butadiyne by hydrogen gas $C_4H_2+2H_2\rightarrow C_4H_6$	Reduced nickel prepared from nickel nitrate. Can replace the nickel by platinum, palladium, or copper	40-80	1	B yield = ?	E. K. Bolton and F. B. Downing (assignors to E. I. du Pont de Nemours & Co.), U. S. Patent 1,777,600 of Oct. 7, 1930
Hydrogenation of butadiyne in acid solution $C_4H_2 + 4CrCl_2 + 4HCl \rightarrow C_4H_6 + 4CrCl_3$ $C_4H_2 + 4CrSO_4 + 4HCl \rightarrow C_4H_6 + 4CrClSO_4$	Chromous chloride solution prepared by action of zinc and hydrogen chloride upon chromic chloride. Chromous sulfate solution prepared electrolytically	Room	1	B yield was 60%-100% on feed	I.G. Farbenindustrie A.-G., German Patent 540,003 of Aug. 13, 1931; Friedlaender's Fortschritte der Teerfarbenfabrikation 18, 753-754 (1933)

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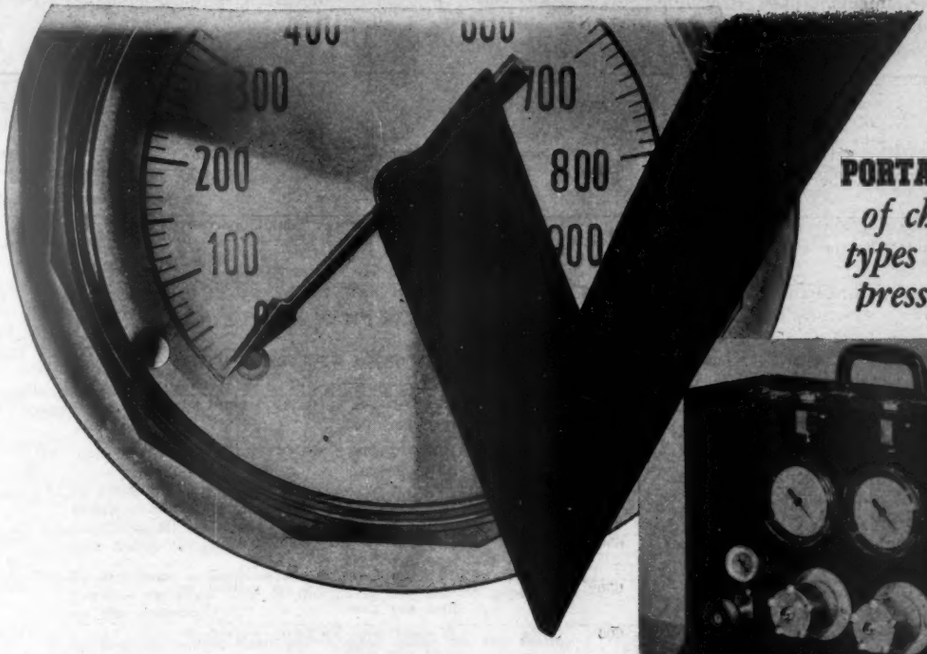

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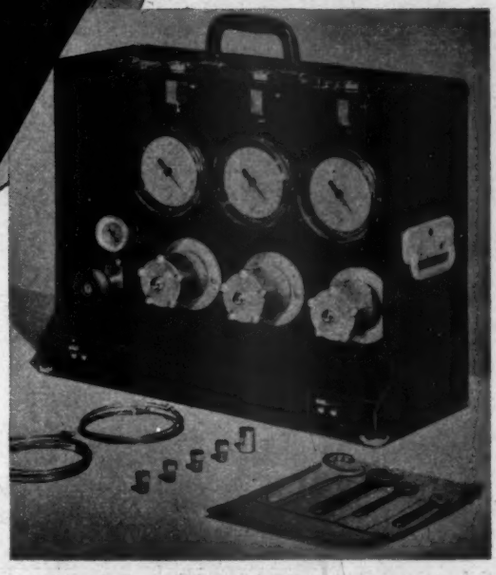

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TABLE 12—HYDROGENATION OF BUTENYNE AND BUTADIYNE (Continued)

Processes	Catalyst or reactants	Temp. (°C.)	Pressure (atm.)	Remarks (B is butadiene-1,3)	References
Hydrogenation of butadiyne in alkaline solution, $C_4H_6+2Zn+4NaOH \rightarrow C_4H_6+2Na_2ZnO_2$	Zinc dust, the oleyl alcohol-ethylene oxide condensation product, and sodium hydroxide solution	Ordinary	1	B yield = ?	W. Reppt, A. Rothhaas, O. Schmidt, and R. Luehdemann (assignors to Jasco, Inc.), U. S. Patent 2,207,070 of July 9, 1940 [This patent is now vested in L. T. Crowley, Alien Property Custodian; Federal Register 7, No. 62, 2417-2424 (1942)]; I.G. Farbenindustrie A.-G., French Patent 834,111 of Nov. 14, 1938

Table 13 gives data on the catalytic dehydrogenation of *n*-butane. The processes are classified into one and two-stage catalytic treatments. In the former, *n*-butane is passed through a dehydrogenation catalyst bed under substantially constant temperature and pressure conditions. The yields vary from 0.035 to 13 per cent per pass. Recycling until the *n*-butane is practically all dehydrogenated can be employed. A pilot plant operating under vacuum conditions is reported to have yielded 74 per cent of butadiene by weight on *n*-butane feed. In the two-stage dehydrogenations, *n*-butane is converted catalytically into *n*-butenes and these alkenes are then subjected to other conditions to yield butadiene.

TABLE 13—CATALYTIC DEHYDROGENATION OF *n*-BUTANE

Process	Catalyst and equipment used	Temp. (°C.)	Pressure (atm.)	Remarks (B is butadiene-1,3)	References
One-stage catalysis $C_4H_{10} \rightarrow C_4H_6 + 2\,H_2$	Cr_2O_3 was the catalyst	400	1	B yield was 0.035% by weight on feed.	F. E. Frey and W. F. Huppke, Ind. Eng. Chem. 25, 54-59 (1933).
One-stage catalysis $C_4H_{10} \rightarrow C_4H_6 + 2\,H_2$	(Cr_2O_3 or MoO^3 or V_2O_5) + Al_2O_3 was the catalyst.			B yields were "small percentages."	A. V. Grosse, J. C. Morrell, and J. M. Mavity, Ind. Eng. Chem. 32, 309-311 (1940).
One-stage catalysis $C_4H_{10} \rightarrow C_4H_6 + 2\,H_2$	Pilot plant. Catalyst composition was not disclosed.	549-649	0.132-0.395	B yield was 74% by weight on fully decomposed feed.	V. I. Komarewsky and C. H. Reiss, The Oil and Gas Journal, 41, No. 19, pp. 33, 37, 39 (1942).
One-stage catalysis $C_4H_{10} \rightarrow C_4H_6 + 2\,H_2$	Vycor tube containing undisclosed catalyst.	650	0.154	B yield was 6.2% by weight on feed per pass.	Ibid.
One-stage catalysis $C_4H_{10} \rightarrow C_4H_6 + 2\,H_2$	Vycor tube containing undisclosed catalyst.	650	0.129	B yield was 8.2% by weight on feed per pass.	Ibid.
One-stage catalysis $C_4H_{10} \rightarrow C_4H_6 + 2\,H_2$	Vycor tube containing undisclosed catalyst.	654	0.138	B yield was 9.8% by weight on feed per pass.	Ibid.
One-stage catalysis $C_4H_{10} \rightarrow C_4H_6 + 2\,H_2$	Vycor tube containing undisclosed catalyst.	651	0.110	B yield was 11.4% by weight on feed per pass.	Ibid.
One-stage catalysis $C_4H_{10} \rightarrow C_4H_6 + 2\,H_2$	Vycor tube containing undisclosed catalyst.	650	0.125	B yield was 13.0% by weight on feed per pass.	Ibid.
One-stage catalysis $C_4H_{10} \rightarrow C_4H_6 + 2\,H_2$	Vycor tube containing undisclosed catalyst.	650	0.120	B yield was 10.8% by weight on feed per pass.	Ibid.
One-stage catalysis $C_4H_{10} \rightarrow C_4H_6 + 2\,H_2$	Vycor tube containing undisclosed catalyst.	600	0.164	B yield was 5.9% by weight on feed per pass.	Ibid.
One-stage catalysis $C_4H_{10} \rightarrow C_4H_6 + 2\,H_2$	Vycor tube containing undisclosed catalyst.	599	0.124	B yield was 6.9% by weight on feed per pass.	Ibid.
One-stage catalysis $C_4H_{10} \rightarrow C_4H_6 + 2\,H_2$	Vycor tube containing undisclosed catalyst.	600	0.145	B yield was 7.7% by weight on feed per pass.	Ibid.
One-stage catalysis $C_4H_{10} \rightarrow C_4H_6 + 2\,H_2$	Vycor tube containing undisclosed catalyst.	599	0.122	B yield was 10.8% by weight on feed per pass.	Ibid.
One-stage catalysis $C_4H_{10} \rightarrow C_4H_6 + 2\,H_2$	Vycor tube containing undisclosed catalyst.	599	0.380	B yield was 11.0% by weight on feed per pass.	Ibid.
One-stage catalysis $C_4H_{10} \rightarrow C_4H_6 + 2\,H_2$	Vycor tube containing undisclosed catalyst.	600	0.0461	B yield was 10.8% by weight on feed per pass.	Ibid.
One-stage catalysis $C_4H_{10} \rightarrow C_4H_6 + 2\,H_2$	Vycor tube containing undisclosed catalyst.	601	0.976	B yield was 1.3% by weight on feed per pass.	Ibid.
One-stage catalysis $C_4H_{10} \rightarrow C_4H_6 + 2\,H_2$	Vycor tube containing undisclosed catalyst.	600	0.991	B yield was 2.2% by weight on feed per pass.	Ibid.
One-stage catalysis $C_4H_{10} \rightarrow C_4H_6 + 2\,H_2$	Vycor tube containing undisclosed catalyst.	600	0.983	B yield was 2.2% by weight on feed per pass.	Ibid.
Two-stage catalysis $C_4H_{10} \rightarrow C_4H_8 + H_2$; $C_4H_8 \rightarrow C_4H_6 + H_2$	$Cr_2O_3 + Al_2O_3$ was the catalyst for both stages.	600 (1st stage) 596.7 (2nd stage)	1 (1st stage) 0.0658 (2nd stage)	Butene yield in first stage was 40.5% by weight on *n*-butane per pass. B yield in second stage was 34.1% by weight on absolute butene. Over-all yield of B was 13.8% by weight on *n*-butane feed, using 1 pass in each stage.	Standard Oil Development Co., British Patent 481,646 of March 15, 1938; P. J. Wiezevich (now P. J. Gaylor) and R. Rosen (assignors to Standard Oil Development Co.), U. S. Patent 2,209,215 of July 23, 1940.
Two-stage catalysis $C_4H_{10} \rightarrow C_4H_8 + H_2$; $C_4H_8 \rightarrow C_4H_6 + H_2$	$Cr_2O_3 + Al_2O_3$ was the catalyst for both stages.	500 (1st stage) 576-7 (2nd stage)	3.062 (1st stage) 0.132 (2nd stage)	Butene yield in first stage was 24.1% by weight on *n*-butane per pass. B yield in second stage was not stated.	Ibid.
Two-stage catalysis $C_4H_{10} \rightarrow C_4H_8 + H_2$; $C_4H_8 \rightarrow C_4H_6 + H_2$	$Cr_2O_3 + Al_2O_3$ was the catalyst for both stages.	482-538 (1st stage) 538-649 (2nd stage)	1.69-5.42 (1st stage) 0.0658-0263 (2nd stage)	Butene yield in first stage was 20-60% per pass. B yield in second stage was 20-40% per pass.	Standard Oil Development Co., French Patent 823,580 of Jan. 22, 1938.
Two-stage catalysis $C_4H_{10} \rightarrow C_4H_8 + H_2$; $C_4H_8 \rightarrow C_4H_6 + H_2$	$Cr_2O_3 + Al_2O_3$ was the catalyst for both stages.	600 (1st stage) 575 (2nd stage)	1 (1st stage) 0.0658 (2nd stage)	Butene yield in first stage was 40.5% by weight on *n*-butane per pass. B yield in second stage was 34.1% by weight on absolute butene. Over-all yield of B was 13.8% by weight on *n*-butane feed, using 1 pass in each stage.	Standard Oil Development Co., French Patent 823,580 of Jan. 22, 1938.

(Continued on next page)

ALL THE ADVANTAGES

Possible in Side-Opening Floating and Guiding Equipment

Without being the least complicated, without any claims that are not supported by logic and field experience, the Larkin Geyser principle gives you all the advantages obtainable in side-opening Floating and Guiding Equipment.

The true functions of side-opening equipment are:

1. To wash the well bore clean at any point at which the fluid action comes in contact with it so that the best possible bond may be obtained between the casing and the formation being cemented off.
2. To distribute cement evenly at the shoe point in order to provide an even flow of the slurry around the pipe and up the annulus.
3. To provide a safe float and rugged guide for the casing string.

Any other claims for it should not be made.

The Larkin Geyser Shoe has a baffled, non-plugging passageway around the entire circumference of the shoe. Slurry issues from this passageway with high velocity, in a cone-shaped sheet and, with a knife-like hydraulic action, strikes with great force against the wall of the hole at an angle designed best to cut the mud cake away. It is much the same angle as that employed by an expert woodsman in wielding his axe against a tree. To facilitate washing out bridges, should it become necessary, part of the slurry leaves the shoe through a restricted opening in the bottom.

When well conditions allow working of the pipe, every square inch of wall surface within the travel of the Larkin Geyser Shoe can be washed entirely free of mud cake.

A fabric-base Bakelite guide and a ball-type valve assembly, stronger than the casing itself, round out the qualifications of Larkin Geyser Equipment. It truly has all the advantages.

LARKIN

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LARKIN HAS CONSISTENTLY BUILT BETTER FLOATING AND GUIDING EQUIPMENT AT NO PREMIUM COST TO YOU

TABLE 13—CATALYTIC DEHYDROGENATION OF *n*-BUTANE (Continued)

Process	Catalyst and equipment used	Temp. (°C.)	Pressure (atm.)	Remarks (B is butadiene-1,3)	References
Two-stage catalysis $C_4H_{10} \rightarrow C_4H_8 + H_2$; $C_4H_8 \rightarrow C_4H_6 + H_2$	$Cr_2O_3 + Al_2O_3$ was the catalyst for both stages.	500 (1st stage) 575 (2nd stage)	3 (1st stage) 0.132 (2nd stage)	Butene yield in first stage was 24.1% by weight on *n*-butane per pass. B yield in second stage = ?	Standard Oil Development Co., French Patent 823,580 of Jan. 22, 1938.
Two-stage catalysis $C_4H_{10} \rightarrow C_4H_8 + H_2$; $C_4H_8 \rightarrow C_4H_6 + H_2$	Cr_2O_3 (5%) + Al_2O_3 (95% by weight) was the catalyst for the first stage. Reaction chamber filled with porcelain balls or quartz pieces was used in the second stage.	500-520 (1st stage) 680 (2nd stage)	1 (1st stage)	Butene yield in first stage was 30-35% on *n*-butane per pass. B yield in second stage was 25-30% by weight on absolute butene (feed gas was devoid of H_2 but had 90.9% of CO_2 as diluent). Over-all yield of B was 7.5-10.5% by weight on *n*-butane feed, using 1 pass in each stage.	I. G. Farbenindustrie A.-G., British Patent 508,764 of July 5, 1939.
Two-stage catalysis $C_4H_{10} \rightarrow C_4H_8 + H_2$; $C_4H_8 \rightarrow C_4H_6 + H_2$	Cr_2O_3 (8%) + Al_2O_3 (92% by weight) was the catalyst for the first stage. Cr_2O_3 (4%) + Al_2O_3 (96% by weight) was the catalyst for the second stage. Product from first stage was fractionated, and undecomposed *n*-butane was recycled.	610 (1st stage) 650 (2nd stage)	Slightly above 1 (1st stage) 0.079 (2nd stage)	Butene yield in first stage was 25% by weight on *n*-butane per pass and about 60% by weight on fully decomposed *n*-butane. B yield in second stage was 17.3-21% by weight on butene per pass and 74.4-78.7% by weight on fully decomposed butene. Over-all yield of B was 45-47% by weight on fully decomposed *n*-butane.	Universal Oil Products Co., British Patent Application 5,997 of April 3, 1940.
Two-stage catalysis $C_4H_{10} \rightarrow C_4H_8 + H_2$; $C_4H_8 \rightarrow C_4H_6 + H_2$	Houdry unit (15,000 tons per year; 6 reactors). Product from first stage was fractionated to give butane + butenes for second stage.	566 (1st stage) 593 (2nd stage)	0.167-0.034 (1st stage)	Butene and B yields in first stage were respectively 31.6 and 4.6% by weight on feed. Over-all yield of B was 67.07% by weight on fully decomposed *n*-butane.	W. T. Ziegenhain, The Oil and Gas Journal, 41, No. 15, 30-31 (1942).

Rubber Maintenance and Conservation Hints

THE most common rubber goods used around the refinery and gasoline plant are gasoline, water, steam and air hose; packing materials; motor valve and regulator diaphragms; insulating materials, and belting. The most important agents that cause rapid deterioration of rubber materials are heat, light, oil, abrasion, and careless handling. These influences must be guarded against in both use and storage.

Various manufacturing concerns have printed and distributed to the consumer booklets concerning the care, use and general maintenance of rubber hose and other rubber materials, especially rubber belting.

The hose used by the industry is often made up of various materials. However, the main constituents are usually rubber, cotton duck, and metals. Those agents that attack the rubber portion often will not attack the cotton duck, but other agents that often cause deterioration of the duck are forgotten in concentrating on the protection of the rubber itself. Those harmful substances include water, alkalies, gases, dilute acids, and rot.

Use Recommended Types

One of the first requisites of good maintenance is to use hose or other equipment that is recommended for the job which it is intended. A careful control and standardization of the plant inventory will help reduce necessary stocks.

When rubber materials are carelessly unpacked the tools used often puncture the carefully packed shipment. After the goods are unpacked, it is often necessary to store the materials for a time before they are put into service. If such should be the case, a cool, dry room should be used. High temperature and direct sunlight should be kept away as these agents tend to deaden the resiliency of the rubber, hardening it and causing it to crack. If the materials so stored contain cotton duck the storeroom should be free from dampness and mustiness. The rubber-goods storeroom should be well removed from electric motors, boilers, steam pipes and generators. Mildew must be watched for as cotton-fabric-covered mechanical goods tend to mildew in certain climatic conditions. Mildew saps the strength from mechanical rubber goods.

When storing after unpacking, or after use, never hang hose on nails, hooks, or other type hangers. It should be laid on the floor, a shelf, or other flat surface.

The hose should be used for the recommended service for which it was purchased and no other as substitution into some other service will in all probability cause destructive action on the tube, or excessive strain on the hose carcass. The hose should never be kinked. Often it is a careless practice to kink the hose to stop the flow of fluid through it. This sort of practice will not only cause unwarranted strain and likely rupture but during these times of scarcity may leave one in the hole for replacement.

Hose couplings are the first things to check when putting a new length into service. They must be the right ones for the job and there is a right and wrong way to put them on the hose. The coupling should be placed in a vise and the hose should be forced straight over the sleeve. The coupling should never be driven into the tube with a mallet or hammer, neither should the hose ever be reamed out to accommodate the coupling.

Hose should be thoroughly cleaned after having been subjected to temperature, oil, alkali, grease, or acid exposure. Hot-water and steam hose should be carefully selected and maintained as an unexpected failure involves tremendous danger to personnel. Be especially certain that no high-pressure steam is allowed to condense in the hose when the pressure is turned off. This sort of condensation will cause the formation of a vacuum that will pull the inner tube away from the carcass. Be sure that proper precautions are taken to guard against the hose being plugged.

A hose should always hang downward in a vertical position to avoid unnecessary strain. The hose should never be connected so that it will kink near the coupling.

Protect Against Crushing

Any reinforced hose must be protected against crushing. If the inner wire reinforcing or metal lining is crushed, the hose is usually damaged so that it is unfit for further service. Therefore, it is of paramount importance that no heavy vehicle be permitted to run over this type of hose, and care should be taken that no heavy tools or other objects are dropped on it.

V-belts are as important in consistent plant operation as is rubber hose. If V-belts are properly installed and cared for, their life will be long. Two rules for obtaining of maximum service are to provide enough belting to transmit the machine maximum peak load, and to religiously adhere to the established minimum pulley diameter for the smaller pulley. Proper alignment of sheaves is quite important for long life, as is cleanliness of the belts, which means that they should be kept wiped free from grease or oil. It is only necessary to wipe a V-belt with a gasoline-wet rag; no belt dressing is needed. When making replacements, put on a complete new set, not a part of a new set. Belts should not be pried into the grooves but should be put on by sliding the motor forward, then backward into the correct position. If matched sets of V-belts are used, the load will be more evenly distributed as each belt will carry its full load.

Belts should be checked frequently for correct tension and sheave grooves should be checked to make sure that they are smooth and have retained their correct shape.

An Invitation to the New SYNTHETIC RUBBER INDUSTRY

Cardox Invites You to Make Use of Its Wide Experience in the Application of Mass Discharge of Carbon Dioxide to Extinguish Fires in War Industries

You who are responsible for synthetic rubber production face one of the biggest jobs on earth today. Don't let fire needlessly delay, by one day or one hour, your meeting production schedules and quotas.

One large fire can knock out an entire plant, destroy costly equipment and wreck or disastrously delay carefully planned schedules. Knowing this, you will not let it happen!

To you Cardox Corporation extends an invitation. Call upon the experience of our engineers. Get the specific answers you seek to your fire extinguishing needs. Benefit from the knowledge they have gained, *engineering* systems to fire conditions in a wide range of war industries, for *engineered* performance under extreme conditions.

CARDOX CO_2

Instant MASS Discharge Extinguishes Fire

Automatically or at the touch of a button, a *mass* discharge (*tons*, if needed) of cold, inert Cardox CO_2 literally engulfs and smothers the fire, extinguishing it completely and cooling combustibles below the ignition point. Here is powerful protection, without damage from the extinguishing medium, and *without* residue.

It is no problem to refill a Cardox System. Ample supplies of Cardox liquid carbon dioxide are constantly available. Through a Cardox-owned and operated fleet of delivery trucks and tank cars, the liquid CO_2 is pumped at controlled low temperature directly into the Cardox Storage Unit. No dismantling of equipment!

Protecting Production in Critical Industries

The majority of manufacturers of aircraft engines used in combat and bomber planes have chosen Cardox Systems to protect their production and plant facilities. Flexibility of Cardox Systems is indicated by the diversity of applications, which include test cells, tung oil units, control rooms, oil and gasoline storage, generator rooms, carburetor test units, transformers and similar hazards.

Other Cardox applications cover a wide range of war industries of critical importance. Specifically *engineered* systems have been selected to guard against the hazards of petroleum fires, quench tanks, outdoor transformers, oil and gasoline pump rooms, hot and cold strip mills, benzol plants and others equally severe.

How Cardox Systems Extinguish Fires in War Industry

- *Timed discharges, as needed, through built-in piping systems . . . supplied instantly from single storage unit holding tons (if needed) of liquid Cardox CO_2, mechanically refrigerated to approximately 0° F.*
- *Mass discharge of Cardox CO_2 "knocks out" fire by . . .*
- *Reducing Oxygen content of atmosphere below concentration necessary for combustion and . . .*
- *Cooling combustibles and fire zone below ignition temperature . . .*
- *Extinguishing fire quickly, completely and entirely without damage from extinguishing medium*

CARDOX CO_2 Systems with Enhanced Fire Extinguishing Performance

A. *Uniformity of CO_2 characteristics*

B. *Extinguishing medium with uniformly greater cooling effect*

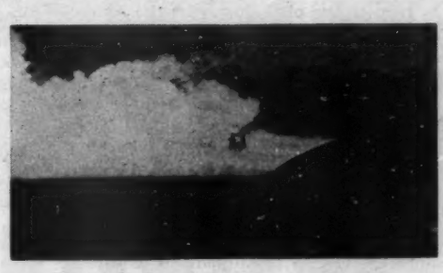
C. *Accurate projection of CO_2 through greater distances and through relatively-strong cross-currents of air*

D. *Timed discharges, as needed, through built-in piping systems . . . supplied quickly from a single tank holding tons of liquid CO_2*

Cardox Systems Provide Protection Under Extreme Conditions

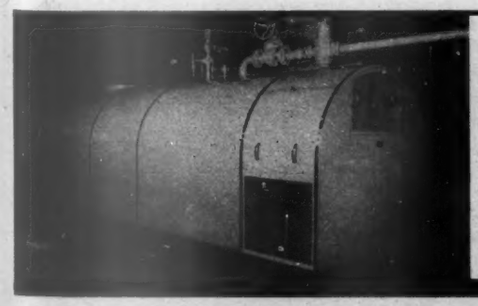
For purposes of demonstration 100 gals. of oil (flash point 350° F.) ignited in outdoor pool. Allowed to burn 2 minutes, 30 seconds.

At height of burning period, release valve opened. Observe how mass discharge of CO_2, applied from fixed linear nozzle shears fire from combustible.



White clouds indicate presence of carbon dioxide enveloping fire zone. Total discharge time 33 seconds.

Complete discharge accomplished. Cooling characteristics of Cardox CO_2 prevent re-ignition. Note CO_2 snow on surface of oil.



Cardox Storage Unit

Maintains in convenient location Cardox liquid CO_2 at constant low temperature. Sizes range from 750-pound capacity, to whatever is required to cover maximum hazard and maintain reserve.

CARDOX

NON-DAMAGING FIRE-EXTINGUISHING SYSTEMS

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Enough Synthetic Rubber Will Be Made—in Time

PRODUCTION of sufficient quantities of butadiene was the biggest problem involved in launching the large-scale synthetic-rubber industry.

It was this end of the program which caused most of the confusion, controversy, and delay during the early stages. Many people confused butadiene with rubber, and when they learned that butadiene could be produced from either petroleum gases or grain alcohol they spoke of "grain rubber" and "oil rubber" as being two different things.

It takes three parts of butadiene to one part of styrene to make buna-S, the mainstay of the synthetic program. As production goals were raised from the pre-Pearl Harbor figure of 40,000 tons annually to present levels of 1,000,000 tons, the butadiene problem seemed to be getting worse instead of better.

Today the problem is solved. Butadiene will be produced by a large number of companies, by a variety of processes, and from several different raw materials.

When Government officials called in the country's synthetic-rubber experts it was natural for them to turn to the oil industry as the source of butadiene. Oil technicians knew several ways of getting butadiene and all patents were pooled. The Koppers United Co., makers of coal-tar products, had a process for making butadiene out of cyclohexane. A plant was scheduled for this process but was later dropped. The Carbide & Carbon Chemicals Corp. had a process for making butadiene out of alcohol, and this was utilized to the limit of what was then thought to be available alcohol supplies. The oil industry was told to produce the rest of the butadiene required.

As the war progressed and the seriousness of the rubber situation became more apparent, many new processes for making butadiene were proposed. Those in charge, the War Production Board and the Rubber Reserve Co., took the position that experiments with new processes would waste valuable time, even though they might be cheaper and better in the long run, but should rush to completion the plants already started. This would have been a perfectly sound position except for the fact that the future requirements for butadiene kept expanding as the size of the synthetic-rubber program was enlarged, and this meant that the advocates of new processes clamored for a share in the expansion.

One of several other factors in last summer's confusion over butadiene was that farm-bloc politicians insisted that grain alcohol be given a bigger place in the program. They claimed that forecasts of an alcohol shortage were incorrect and, whether or not because of these claims, the WPB did provide an increase in alcohol producing capacity. As a result the Carbide & Carbon process of producing butadiene from alcohol was expanded.

It was also charged that the Government failed to give consideration to two other grain processes. One was an alcohol-butadiene process, said to be simpler than the Carbide & Carbon process, invented by a Polish refugee. After much fuss WPB gave the Publicker Commercial Alcohol Co. priorities for a pilot plant in Philadelphia and experiments with this process are now proceeding. The other process eliminated the alcohol step by fermenting grain into bulylene glycol. This process was developed jointly by the Northern Research Laboratory of the U. S. Department of Agriculture at Peoria, Ill., and by Joseph E. Seagram & Sons, Inc., distillers of Louisville, Ky. A pilot plant was also authorized for further study of this process.

Meanwhile, all was not going smoothly with the plans for getting butadiene from the oil industry. In petroleum chemistry the parent product of butadiene is butane. Butane is a constituent of natural gas and is also present in refinery gases. The butane molecule is composed of four carbon atoms in a row, entirely surrounded by ten hydrogen atoms. The first process is to remove—dehydrogenate—two of these hydrogen atoms, and the resulting product is butylene. Butylene is a very necessary material for making 100-octane gasoline. When two of its hydrogen atoms are knocked off by further dehydrogenation the result is butadiene.

Refineries Converted to Make Butadiene

When the Government's program started, practically all the butadiene was to be made from butane because there is theoretically an abundance of butane. But this meant a number of large, complicated, and expensive plants to extract the butane from petroleum or natural gas. So much critical material and engineering work were required that it was decided last summer to change the program and use butylene as the starting point. It was calculated that sufficient butylene would be available from other refineries to make both butadiene and aviation gasoline.

This decision aroused those who had processes for making butadiene out of butane, as well as of the natural-gasoline manufacturers who had an excess of butane. They claimed that with the inevitable expansion both of the rubber and aviation programs there would not be enough butylene to make both butadiene and 100-octane gasoline. There also have been intense but not very conclusive arguments over the costs of various processes and particularly the amounts of steel, copper, and other critical materials needed for various types of plants.

Partly because of this situation the Office of Petroleum Coordinator last summer launched its refinery-conversion program. The objective was to get all possible petroleum refineries, large and small, to making butane, butylene, butadiene, aviation-gasoline components, and any other petroleum war products which they could make, utilizing any second-hand equipment they could find and any available processes at hand. As a result, butadiene is now being made from petroleum and natural gas by a number of different processes, but all of them involve knocking part of the hydrogen out of intermediate products.

Cost of the butadiene is not a primary consideration during the war. Far more important are minimum use of critical construction materials and availability of raw materials not needed for some other phase of the war program.

The construction program now under way and the processes which these plants will use are certain to produce butadiene of the needed purity. The speed with which the program is advancing gives assurance that the butadiene will be available to produce the synthetic rubber called for by the war schedule.

Construction of plants to produce styrene and to copolymerize the two into buna-S rubber is much simpler than the butadiene construction program and is more advanced. Also the chemical processes in making styrene and in copolymerization are surrounded with more technical "know how" than is the production of butadiene. Doubtless much can be learned in both of them and new wrinkles and shortcuts may be developed, but the experts have said all along that once the butadiene problem was licked the rest would be easy.

There remains an unexplored territory in handling the crude synthetic rubber once it comes out of the copolymer plants, but this is the job of the rubber-fabricating technicians and they are working on this day and night.

CAPACITIES, FEED STOCKS, AND DATES OF COMPLETION OF BUTADIENE PLANTS, AS OF NOVEMBER 20, 1942

Operator—	Date to be completed	Type of process	Feed stock of raw materials	Capacity (short tons)
Shell Chemical	3-43	Thermal cracking	Mixed H.C.	85,000
Atlas Oil	11-42	Thermal cracking	Mixed H.C.	9,500
Standard Oil (La.)	9-42	Thermal cracking	Mixed H.C.	8,300
Carbide & Carbon	9-42	Thermal cracking	Petroleum byproduct	5,000
Humble Oil	3-43	Catalytic dehydrogenation	Butylene	30,000
Standard Oil (La.)	3-43	Catalytic dehydrogenation	Butylene	15,000
Imperial Oil, Ltd.	6-43	Catalytic dehydrogenation	Butylene	30,000
Neches Butane Products	4-43	Catalytic dehydrogenation	Butylene-butane	50,000
Neches Butane Products	6-43	Catalytic dehydrogenation	Butylene-butane	50,000
Sinclair	10-43	Catalytic dehydrogenation	Butylene-butane	50,000
Cities Service	8-43	Catalytic dehydrogenation	Butylene-butane	55,000
Phillips Petroleum	4-43	Catalytic dehydrogenation	Butane	45,000
Sun Oil Co.	3-43	Catalytic dehydrogenation	Butane	15,000
Koppers United	4-43	Carbide	Alcolohl (50,100 gal./day)	20,000
Koppers United	5-43	Carbide	Alcolohl (50,100 gal./day)	20,000
Koppers United	6-43	Carbide	Alcolohl (50,100 gal./day)	20,000
Koppers United	7-43	Carbide	Alcolohl (50,100 gal./day)	20,000
Carbide & Carbon	5-43	Carbide	Alcolohl (50,100 gal./day)	20,000
Carbide & Carbon	6-43	Carbide	Alcolohl (50,100 gal./day)	20,000
Carbide & Carbon	7-43	Carbide	Alcolohl (50,100 gal./day)	20,000
Carbide & Carbon	1-43	Carbide	Alcolohl (50,100 gal./day)	20,000
Carbide & Carbon	2-43	Carbide	Alcolohl (50,100 gal./day)	20,000
Carbide & Carbon	3-43	Carbide	Alcolohl (50,100 gal./day)	20,000
Carbide & Carbon	4-43	Carbide	Alcolohl (50,100 gal./day)	20,000

PUTTING PERMANENCE IN PIPE

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Complete Reconditioning Service for Old Pipe

Rubber Outlook Improved By Early Progress

THE Japanese raid on Pearl Harbor December 7 not only put the United States into war on two fronts—it threatened to sever the country entirely from one of the most essential commodities of war and of domestic economy—rubber.

For 98 per cent of United States rubber came from Far East plantations obviously in the path of Nipponese aggression and the other 2 per cent came by submarine-stalked shipping routes from South America and Africa. Already, some 90 per cent of the world's commercial rubber-producing areas are in Japanese hands and the sole remaining source of any consequence—Ceylon—is not out of danger.

If the Axis leaders had schemed how to injure the United States most they could have found no better answer than to cut off rubber. They very nearly succeeded in doing so, and this very nearly proved fatal. For months the most optimistic thing that could be said about the rubber situation was that it was desperately critical.

But today, less than a year after Pearl Harbor, ways out of the dilemma have been found. American chemical and engineering genius has the rubber problem well on the way to solution.

Last spring America was a "have not" nation as regards rubber. A year from now it will definitely be a "have" nation.

The year in between—1943—will be rather tough. There are still many problems to be licked, though these are not so stupendous and perplexing as the obstacles already surmounted. Much construction work remains to be done, many important details must be worked out. For the next 12 to 18 months rubber consumption must be most parsimonius and frugal. But instead of a frugality of despair, like a castaway cutting his rations in half each day to postpone inevitable starvation, it is a purposeful economizing to tide over an assuredly temporary period of relative scarcity.

The way out is based on four routes being traveled simultaneously—natural rubber, reclaimed rubber, conservation of tires, and synthetic rubber. The greatest of these is synthetic rubber, but while we are getting squared away to roll out a million tons of this a year reliance must be on others.

Crude Stocks

Stocks of natural crude rubber on July 1, 1942, was 578,000 long tons—a normal peacetime year's supply but pitifully meager to fight a global war. At that time it was estimated that imports, in one way or another, would aggregate 12,000 tons of crude rubber during the last half of 1942, 41,000 tons during 1943, and 68,000 tons during 1944. This was probably a conservative estimate because the United States is getting probably a third of the rubber production of Ceylon and the most strenuous efforts are being made to increase production from wild rubber trees in the tropical regions of the hemisphere. Dramatic tales are told of airplanes flying out a ton or two of tropical rubber per trip, and of natives slashing paths through the jungles to locate and tap trees, but when this is all added together the experts agree that it will not come even close to meeting rubber requirements.

There was also the possibility of growing rubber in this country from such rubber-bearing plants as the desert guayule shrub, the creeping cryptostegia vine, and the Russian kok-sagyz dandelion. The Department of Agriculture is planting and experimenting with these plants and they show considerable promise of yielding very usable rubbers, but even the most optimistic estimates of quantity yields fall far short of meeting a substantial portion of our requirements during the next 3 or 4 years.

The supply of reclaimed rubber—which gives far fewer miles per tire than natural rubber—was estimated at 207,000 tons during 1942, at 360,000 tons during 1943, and at 400,000 tons in 1944. Reclaiming facilities are being expanded, but there is little expectation that these estimates will be greatly exceeded, and after a couple of years the supply might dwindle because very little rubber can be reclaimed from battlefields.

Against these meager supplies of natural rubber government officials placed forecasts of demands for United Nations as shown in Table 1. Though subject to change, these forecasts as of midsummer were as follows, in thousands of long tons:

TABLE 1—PROJECTED RUBBER DEMAND

	1942*	1943	1944
Military	138	325	325
Private transportation	1	3	3
Commercial vehicles	28	59	85
Other civilian uses	24	49	50
Foreign countries	74	117	103
British deficiency	0	24	106
Total	265	577	672

*Second half.

These estimates included nothing whatever for tires for civilian passenger cars. The allocation for "private transportation," small as it was, is only sufficient to mix with whatever reclaimed rubber might be available in making tire recaps already on the ground. The "other civilian uses" was for articles other than tires such as electrical insulation and belting for factories, and the "commercial vehicles" classification included only tires for essential trucks and buses.

It was therefore obvious, early last spring, that alternates for rubber must be found. The Government turned to America's chemists and asked them to create, almost over night, a synthetic-rubber industry which would obviate imports.

Then began a period of experimentation, so mixed with baseless rumors, misinterpreted half-truths, and political pressures, that the public state of mind vacillated from day to day from unbounded optimism that synthetic rubber was just around the corner to doubts that a synthetic-rubber industry worthy of the name would ever result. Every crackpot, every kitchen experimenter, as well as every established research laboratory, went to work on the problem and some weird "solutions" were offered—ranging from wooden tires to "rubber" made from potato peelings in a bathtub.

Now, fortunately, there is a definite program for synthetic rubber well under way. Certain now are the best types to make, what raw materials to use, how to make it, and how to use it. Several plants are already in production, many more are well along in construction. Because of the rapid progress in the art, many plants may be obsolete by the time they are finished and a couple of years from now certain other processes may have been proven a lot better. But in any event the programmed plants and processes will be turning out satisfactory rubber to win the war. Time prevents exhaustive research to find which is the very best process.

At the time of Pearl Harbor, Germans and Russians had been making much of their own rubber for some years, but American chemists didn't known too much about how they did it nor how good a product they obtained. Several American companies were then producing relatively small amounts of various types of synthetic rubber-like materials with peculiar properties justifying their high cost for specialty uses, and the Government was financing a small pilot-plant program to experiment with buna-S, which seemed to be the best for tires.

How Much Synthetic Needed?

As it became more and more obvious that reliance could not be made on imports of natural rubber, the Government was faced with a whole series of problems which seemed to defy solution for months. Major among these were: How much synthetic rubber would be needed? How much would it be possible to make? Which of the several types of synthetic should be made and in what proportions? What processes and patents should be used? What type of equipment was needed? What industries and companies should get the contracts? What raw materials were suitable or available? What government agencies should direct the program?

The program did not wait solution of all these problems. Plants were started, relocated, redesigned, canceled, expanded, but still progress was made. But there was so much uncertainty about the whole program. During the spring and summer several congressional committees investigated the problem, and finally President Roosevelt appointed the famous Baruch committee, composed of Bernard M. Baruch, Karl T. Compton, and James B. Conant. After a rapid survey, aided by technical experts, this committee on September 10 made a concise report on the whole rubber situation. It recommended few radical changes in the program itself, but the report so clarified the picture and straightened out the administration of the program that progress since has been rapid.

Many problems remain, but they are being attacked vigorously by the best technical brains of the country. Chief among the remaining problems are how to work and fabricate synthetic rubber, particularly the buna-S tire stocks. It took the rubber industry 20 years to learn how to get the most out of natural rubber, and now it must, in the space of months, do the same thing with synthetics. The fabricators must learn the best methods of curing and vulcanizing synthetic rubber, and what are the best extenders, plasticizers, fillers, accelerators, retarders, and other additives. For the manufacture of rubber, as the term is used by the industry, starts with the bales of crude, which is where ends the synthetic phase.

Meanwhile, the synthetic producers have many problems of their own. Although the basic processes are established and some of the plants are already in production, there are countless refinements to be made. Unpredictable "bugs" inevitably develop in any new plant or process, and they can only be ironed out by trial and error. Technicians must be trained and operating crews assembled. It will take some time after scheduled completion dates before all the plants are producing at capacity and their output is flowing smoothly through the various stages required to make a tire from oil or grain.

But the remaining problems are minor compared to those that have already been licked. We have gone so far already that America can now be sure that it will have the rubber it needs.

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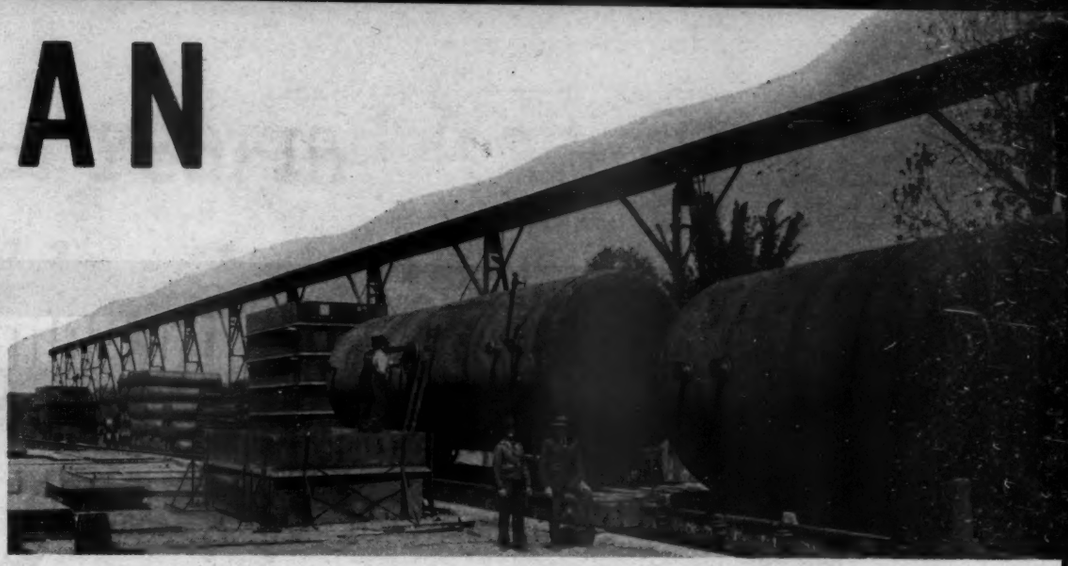

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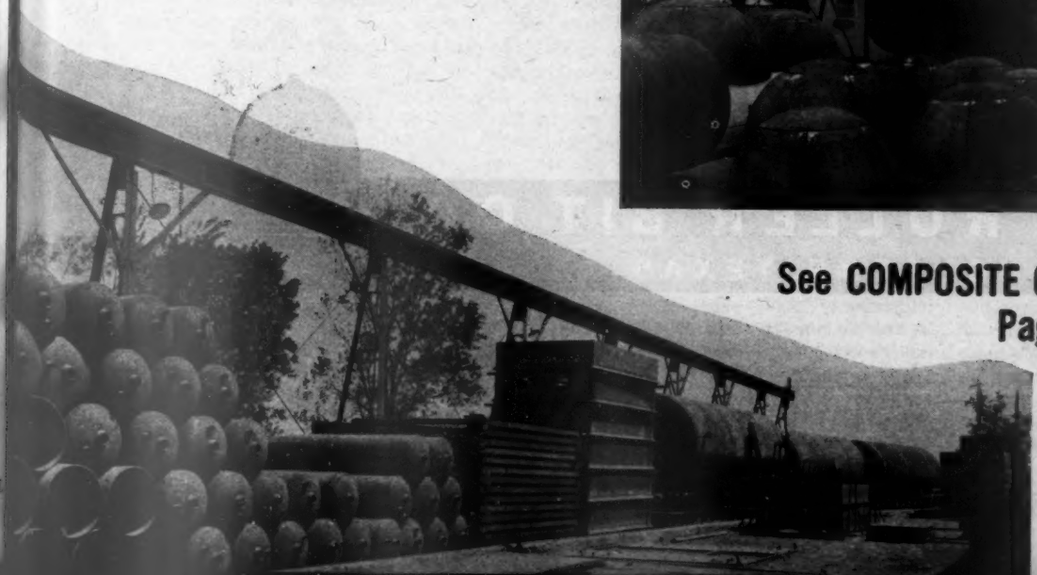

See COMPOSITE CATALOG Refinery Equipment Pages 543-544

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1943 Critical Year in Civilian Rubber Supply

WHAT are we going to do for tires until such time as our new synthetic industry can meet all demands?

For months official Washington said: Do without.

Now, a more realistic viewpoint has been adopted, and a program is well under way to keep the nation's cars tired for essential driving for the duration. But emphasis is on essential. Tires are going to be hard to get and most of those that civilians get will be of relatively poor grade. They must be given the best possible care and driven as few miles as possible.

That is the reason for nation-wide gasoline rationing, officially termed mileage rationing although the name makes it no more pleasant to the oil industry.

But mileage rationing is only a part, and probably only a temporary part, of the civilian tire program. In place of the dire threats of no tires at all and undiluted pessimism regarding civilian driving, the administration now has a positive and promising program to keep our 27,000,000 passenger cars and 5,000,000 trucks on the road.

Features of Program

Basic features of this program are:

Mileage rationing to confine the use of non-commercial vehicles to "essential driving."

Control of the use of commercial vehicles through certificates issued by the Office of Defense Transportation.

Maximum speed limit of 35 miles per hour for all vehicles.

Periodic inspection of all tires to insure careful use and maintenance.

Rationing of tires and recapped used tires to all vehicles in quantity and quality sufficient to permit those vehicles to travel their allotted essential mileage.

Production and distribution of these tires and recaps, made of whatever material will serve without robbing military uses of needed supplies.

Several federal agencies are cooperating in this program, but it is under the general direction of Rubber Director William M. Jeffers, who is following the outline laid down in the report of the Baruch committee.

This embodies the thesis that about half of our normal annual car mileage must be maintained to keep up production and services essential to the war. Unrestricted tire use would require about 200,000 tons each of crude rubber and reclaim for replacements during 1943. Such quantities cannot be spared. But by cutting mileage in half and taking every step to make tires last it will be possible to supply some sort of tires until the synthetic program reaches maximum capacity, though even this will cut reserve stocks to a dangerously low margin.

Tire materials estimated to be available for civilian transportation during 1943 were 76,000 tons of reclaim, 54,000 tons of thiokol, and 3,000 tons of natural crude rubber for necessary blending and cements, a total of 133,000 tons. For 1944 the estimated supplies available are 106,000 tons of reclaim, 60,000 tons of thiokol, 15,000 tons of butyl, 185,000 tons of buna-S, and 3,000 tons of natural, a total of 369,000 tons.

Since military requirements come first, any unscheduled increase in military needs must come out of civilian tires. Production of all these types of tire material is being pushed in the hope that output may be above schedule to allow for such contingencies or to permit the release of more tires to civilians. Even so, the supply must be stretched by using recapped tires instead of whole new ones wherever this is feasible.

These plans apply only to passenger cars. The government program from the first has included rubber for tires for commercial vehicles on runs considered essential to the war and to civilian economy, but it was not until the appointment of Director Jeffers that there was any definite plan for civilian passenger cars, although both the rubber and the oil industry had been urging such programs for months.

Can the country's 27,000,000 passenger cars be kept operating on the meager amounts of reclaim and synthetics estimated to be available? There is evidence that they can be. In normal years approximately 250,000 tons of crude rubber have been used to make tires and tubes for passenger cars, whereas the present program calls for 133,000 tons of reclaim and thiokol for 1943 and 369,000 tons of various tire materials in 1944. Reclaim and some of the synthetics, perhaps all of them which are allowed to go into civilian tires, do not give the mileage of crude rubber so a ton-for-ton comparison does not tell the whole story, but against this must be balanced the enforced reduction in driving and presumably better care to be given their tires by all civilian drivers.

The Baruch committee estimated that these amounts of rubbers would maintain passenger cars for essential driving. A strikingly similar conclusion was reached last May by the Petroleum Industry War Council in a special study by its committee on synthetic rubber. A program was worked out of the amounts of rubber required to produce recaps and new tires to keep on the road all passenger cars in mechanically usable condition, assuming careful use of tires and only essential driving. No synthetics of any kind were counted on for passenger cars, and the entire proposal was based on reclaimed rubber plus the smallest amount of natural crude considered necessary for blending and cementing.

1943 Requirements

The council estimated that this would require during 1943, 8,400 tons of crude and 103,900 tons of reclaim, a total of 112,300 tons, and in 1944 it would require 10,000 tons of crude and 147,500 tons of reclaim or a total of 157,000 tons.

These quantities of crude and reclaim are greater than the amounts which the Baruch report said could be spared for passenger-car tires and recaps, but their totals are less than the totals of all tire materials allocated to passenger cars by the Baruch report. The production of thiokol and butyl rubber expressly for passenger-car tires was proposed by the Baruch committee for the purpose of keeping civilian cars on the road without imposing such a drain on the supplies of natural and reclaimed rubber.

Similarly, the Rubber Manufacturers Association last July proposed a plan for keeping civilian passenger cars on the road, calling for minimum driving and maximum tire care, and release of some of the stocks of frozen tires and production of recaps and whole tires from reclaim, thiokol and butyl. The association estimated raw materials requirements as follows: For the period July 1, 1942, to June 30, 1943, 1,189 tons of crude rubber, 48,769 tons of reclaim, 10,688 tons of thiokol, and 2,475 tons of butyl, or a total of 63,121 tons; for the period July 1, 1943, to June 30, 1944, 2,143 tons of crude, 48,651 tons of reclaim, 22,500 tons of thiokol, and 30,000 tons of butyl, or a total of 103,294 tons.

Again these totals are less than what the Baruch report says may be made available.

Expansion of thiokol and butyl capacities is now under way. Butyl tires will probably give 40 or 50 per cent of the mileage of natural-rubber tires, and thiokol and reclaim about 20 to 25 per cent—but they are tires. They must be run at low speeds to prevent unrepairable blowouts caused by high temperatures and excessive strains. The rubber association stated that in estimating quantities of raw materials required for passenger-car tires, thiokol can be substituted for reclaimed rubber on the basis of 100 tons of thiokol for each 80 tons of reclaim, and butyl can be substituted in the ratio of 100 tons of butyl for each 140 tons of reclaim.

Estimates of materials required for civilian tires have been projected into 1945 and beyond, but they get into too many imponderables to be worth much. No one knows with any certainty how many passenger cars will be left in mechanically usable condition, how much mileage the various kinds of "war tires" will give as methods of making them improve, what the United Nations' military demands for rubber may be then, or how much natural and synthetic rubber may be available 3 years from now.

Critical Year

But everyone agrees that 1943 is the critical year for rubber, and plans are being made on the assumption that if we can get through the next 15 months or so we ought to have enough rubber of one kind or another to keep us operating.

So the "tires for everyone" plan has a lot of strings to it. It does mean tires for everyone, but just barely enough tires to get by. The chief method of control, in addition to the 35-mile speed limit, is gasoline rationing.

The gasoline-ration system, scheduled to start December 1 (except in the eastern area where it has been in effect since July), limits every passenger car to the minimum essential mileage. The mileage of trucks and other commercial vehicles is being controlled by a different system through certificates of war necessity issued by the Office of Defense Transportation.

Since the "tires for everyone" plan was adopted the Government has authorized resumption of manufacture of tires from reclaimed rubber, and has also increased the production of reclaimed rubber camelback for recapping tires. It is hoped, but not guaranteed, that there will be sufficient supplies of both to fill all the needs certified as required by the local ration boards. As yet no plans have been announced for putting butyl or thiokol tires into the rationing system.

Manufacturers say a reclaim tire will give around 10,000 miles of service if not underinflated and if not driven faster than 35 miles per hour, and thus should last the average motorist about 2 years under present driving restrictions. The reclaim camelback now being made under specifications of Office of Price Administration is said to give between 5,000 and 10,000 miles of city driving if properly applied to a casing with sound side walls. For commercial use OPA is permitting the manufacture of a better-grade cambelback containing 38 per cent crude rubber.

For several months this country experimented and gossiped furiously about substitutes for tires out of wood, springs, feathers, and about everything else that could be imagined. Now a practical program has been worked out to make use of what rubber we have most efficiently, to keep America's cars in operation but restricted, until the rubber shortage is licked, to essential driving only.

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Federal Mechanism for Directing Synthetic Rubber Industry

(Continued from Page 32)

(*c*) We recommend that particular care be directed to the establishment of a technical division, under the immediate control of the rubber administrator.

(*d*) We also recommend that the construction division of Rubber Reserve be designated by the rubber administrator as the agency to supervise the construction of all plants under the rubber program.

(*e*) We further recommend that the petroleum coordinator be directed by presidential order to act on specific directives from the chairman of WPB, acting through the rubber administrator, to explore all methods for the production of butadiene from petroleum and natural gas products and recommend new proposals to the rubber administrator for his consideration and action.

(*f*) The construction of all plants and equipment concerned with the production and purification of butadiene from petroleum should be under the authority of the rubber administrator, who we recommend shall designate the construction division of Rubber Reserve to carry out this function.

(*g*) We further recommend that in the Office of Petroleum Coordinator there be created a new technical division responsible for research and development in connection with all problems of the manufacture of butadiene from petroleum; funds for this purpose should be provided to OPC.

Jeffers Appointed Director

The committee's report was made September 10, 1942. On September 15 Mr. Jeffers was appointed rubber director. On September 17 President Roosevelt issued Executive Order 9246 giving him the authority recommended by the Baruch committee. Since then Mr. Jeffers has moved rapidly to put the rest of the recommendation into effect.

William M. Jeffers is president of Union Pacific Railroad on leave of absence to serve as a government official. This makes him a big-business executive, and railroad executives have a reputation for being unusually hard-boiled; so, to start, Mr. Jeffers has the executive ability and decisiveness stipulated for the position. But Mr. Jeffers is even tougher than most of them and he got to be a big executive the hard way.

The authority vested in him by the president is shown in the executive order, which authorizes him to direct any agencies of the Government as he may deem necessary, "and full compliance shall be accorded such directives by the federal agencies concerned."

Recruit Technical Staff

One of the first things Mr. Jeffers did was to recruit the technical staff as recommended. As deputy rubber director he named Col. Bradley Dewey, an eminent technologist in synthetic rubber.

Colonel Dewey is associated with Dewey & Almy Chemical Co., one of the pioneers in synthetic-rubber research in the United States.

Other members of the technical staff so far announced are:

E. B. Babcock, Akron, Ohio, chief chemist for Firestone Tire & Rubber Co. Mr. Babcock has been active in the development of synthetic rubber for a number of years and is thoroughly familiar with European developments as well as those in this country.

L. D. Tompkins, Wilton, Conn., vice president of U. S. Rubber Co. He formerly was in charge of the development, production and sale of tires for his company and was active in the development of U. S. Rubber's far-eastern plantations.

Dr. E. R. Gilliland, Cambridge, Mass., professor of chemical engineering at Massachusetts Institute of Technology. He is coauthor of the standard text book on chemical engineering and has done considerable consulting work on petroleum technology.

W. L. Campbell, New York City, formerly was vice president of Kroger Grocery Co. in charge of manufacturing and plants.

Morehead Patterson, New York City, president of the American Machine Foundry Co. In addition to wide experience in organizational problems, Mr. Patterson is thoroughly conversant with the production and use of industrial machinery.

Ray P. Dinsmore, Akron, Ohio, manager of development for Goodyear Tire & Rubber Co. He is in charge of all research for the company, in both crude and synthetic rubber, and for several years before the war was in close touch with German synthetic-rubber development.

Frank R. Creedon, chief construction engineer in the Office of Chief of Engineers, U. S. Army, a graduate of Massachusetts Institute of Technology, formerly chief engineer of the Public Works Administration in charge of all construction work in the 11 northeastern states.

These technical men, with other assistants being added, have completed topside authority over the entire program. In matters of research and operations they make use of other agencies of the Government, not only those shown on the accompanying chart but also the research facilities of scientific staffs of the federal Government.

Recommendations (*d*), (*f*) and (*g*) of the Baruch report have not been followed literally, though they have been in spirit and intent. The construction division of Rubber Reserve has been absorbed into the office of rubber director in order to provide more intimate supervision and a more direct line of authority. The construction division, under the supervision of Assistant Deputy Frank R. Creedon, supervises the construction of all plants in the synthetic program, including butadiene from petroleum and alcohol, styrene, copolymerization, specialty rubbers, and government-financed additions to rubber-fabricating plants.

No new technical division has yet been created in the Office of Petroleum Coordinator, but the technical men in the OPC refining division are functioning as such in close cooperation with the rubber director's technical staff.

Although not mentioned in the Baruch report, the rubber director has also absorbed the old rubber branch of WPB. In its capacity as rubber branch, the director's office handles all WPB matters relating to the rubber-goods-manufacturing industry.

Agencies All Cooperating

During the early days of the program last spring persons desiring to participate by making synthetic rubber of raw materials had great difficulty in determining just who in Washington had the authority. There still is no clear-cut, publicly announced demarcation of jurisdiction, but this is of no importance now that all the agencies concerned are in the "Jeffers family" and are cooperating with each other, and because no more plant-construction contracts are in prospect except possibly another coplymerization plant or two and some relatively small feed-stock plants.

Contracts for construction are held by the Defense Plant Corp., and contracts for operating the plants and purchase of feed stocks are held by Rubber Reserve Co., and the rubber director has not upset these relationships. Refinery conversion is being handled by the Office of Petroleum Coordinator in the first instance, and OPC passes on all technical details of a proposal from an oil company to make butadiene and determines how such a proposal fits in with programs for making other petroleum war products. A recommendation from OPC goes to the rubber director and if he determines that the additional butadiene is needed the proposal goes to Rubber Reserve for negotiation of a contract to purchase the butadiene and, if government financing is required, to DPC, while OPC supervises construction and passes on priorities.

In the case of a proposal to make alcohol as feed stock for one of the Government's alcohol-butadiene plants, the alcohol section of the WPB chemical branch would pass on the proposal and supervise construction, provided the rubber director approved the need for more alcohol and Rubber Reserve entered a contract to purchase the output. Similarly, styrene plants come under the immediate jurisdiction of the WPB chemical branch, subject to policy determinations by the rubber division.

The rationing of rubber articles to the public, and of gasoline to conserve rubber, is the function of the Office of Price Administration, but OPA gets its rationing authority only through directives issued by the War Production Board, so Director Jeffers has ultimate control there.

To all appearances the various federal agencies having to do with rubber are all cooperating like one big family. If there have been any squabbles they have been settled in private, and Mr. Jeffers has both the authority and the disposition to take any errant children out to the woodshed. He is "bulling" the program through with all the force and speed he can muster, and force and speed have been his specialty all his life.

Left: Col. Bradley Dewey, deputy rubber director, is one of the pioneers in the development of synthetic rubber and before the start of the war had made exhaustive investigation of developments in Europe. He is associated with Dewey and Almy Co.
Right: Dr. R. P. Dinsmore, research director for Goodyear Tire & Rubber Co., is on indefinite leave of absence to head the entire rubber-research division of War Production Board, under W. M. Jeffers, rubber director. He is a pioneer in synthetic-rubber research

ENGINEERING *and Operating* SECTION

Reducing Refinery "Offstream" Time By Desalting of Crudes

By NEIL WILLIAMS

Because of the need for maintaining production of refineries at maximum levels, desalting of crude oil is becoming a more essential phase of operation than ever before. Most all crude oils carry salt, which, if not removed in advance, is deposited in refinery systems, forcing shutdowns and lost operating time while being cleaned out. Salt also results in corrosion of refinery equipment, requiring replacements using scarce metals. Development of effective and efficient methods for removing salt from crude oil is receiving increasing consideration by refiners.

PETROLEUM as it comes from the ground usually contains impurities, including water and earths and their salts, that degrade the oil, and, if present in sufficient quantities attack the well equipment, pipe-line facilities and refinery installations. Most of these impurities are removed by treating and settling operations in the fields and at storage centers during the course of producing and handling the oil. Generally, however, a considerable amount of salt remains in the oil and comes to refineries where it presents a major problem in plant operation.

Salt content of the crude oil at refineries varies greatly, depending upon the nature of the original crude and the previous treatment which the oil has received, but usually runs from 30 to 100 lb. per 1,000 bbl. If allowed to remain in the crude charge, this results in accumulations in various places in the system, necessitating shutdowns and "offstream" time for cleaning out.

Principal trouble along this line is occasioned by plugging of exchanger tubes and condenser sections. The salt usually is present in a water solution emulsified with the oil. When the charge is passed through preheating exchangers, and sufficient temperature is reached in the exchanger to vaporize the water, the salt is precipitated, adhering to the tube walls and eventually plugging the tubes. Salt present in minute crystalline form also is deposited in the tubes and in other parts of the system.

Corrosion is another result of salt in the crude. Chloride salts of calcium and magnesium hydrolize to produce free hydrochloric acid gas. This attacks the iron to make iron chloride. Hydrogen sulfide present in some oils reacts on the iron chloride, forming iron sulfide and liberating hydrogen chloride, which again attacks more iron.

The corrosion trouble is accentuated when crude oil produced from acidized wells is run. In the wells, the acid reacts with the producing formation to yield water-soluble chlorides, mainly of magnesium, calcium and sodium. Sodium chloride usually predominates but calcium and magnesium chlorides are present in appreciable quantities.

Salt in the crude also has undesirable effects on refined products, principally asphalt and heavy fuels, produced from the oil. Authorities disagree as to the precise nature of the reaction between salt and asphalt, but it is definite that salt prevents some asphalts from meeting certain specifications which a number of customers have set up.

In view of these conditions, increasing consideration has been given by refiners to the development of methods and facilities for desalting the crude. Special incentive for desalting is given at this time by the urgency for means to insure maximum operating time for plants and to conserve metals and materials by elimination of corrosion. Plant shutdowns to remove salt accumulations lead to tremendous loss of "on-stream-time." Prevention of corrosion is especially vital since replacements of equipment are difficult.

At the same time there is a growing salt problem. With increased operations and more restricted supplies, most refiners are having to run closer to oil production and crude oil does not have opportunity to remain in storage tanks as long as it formerly did. Consequently, there is not as much time for the usual methods of desalting and dehydration to function before the crude reaches the refinery, which tends to cause an increase in the salt content of the oil received.

Difficulties in desalting lie in breaking the films of the emulsifying agent that encase the dispersed droplets of brine of the emulsion so that the droplets may coalesce with other droplets to form drops of sufficient size to separate from the oil by gravity. Emulsions in crude received at refineries usually are tight and stable and hard to break inasmuch as they have not been resolved in previous treating and settling operations in the fields and at storage centers. The minute emulsified brine droplets are so well distributed throughout the oil that the necessary intimate contact with the resolving medium sometimes is hard to make. Most oils also have been found to carry in suspension fine salt particles encased in a hard wax or oily substance. Frequently these are more difficult to break down and separate than the emulsified brine solution.

Various methods have been employed for destroying the emulsifying films of these emulsions to free the dispersed brine droplets for separa-

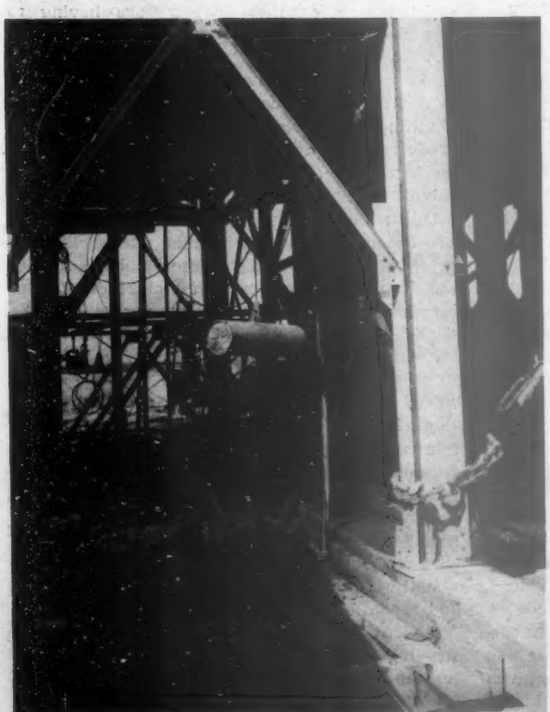
(Continued on Page 161)

Operating Ideas

Revolving Tool Rack Saves Space

A revolving tool rack which has been devised by a Gulf Coast drilling crew not only provides a compact means of keeping tools together but also makes selection and inspection of tools more convenient. The arrangement also permits tools to be hosed down without wetting other equipment around the rig. A gate wheel is mounted on a 1½-in. stub which turns freely within a 2-in. pipe set up as a supporting post. The tools hang from short chains welded to the rim of the wheel. Ends of the chains have hooks of ⅜-in. steel, formed to hold the shanks of the various tools. The post can be driven in the ground or mounted on a floor base, and can be moved quickly and conveniently.

Tong Counterweight Held Horizontally



By suspending the tong counterweight, operating below the derrick floor, horizontally instead of vertically, as usually is done, a Texas drilling contractor provides greater clearance below the counterweight at its lowest operating position, and thus reduces a hazard for crewmen who might be working below the derrick floor. The conversion was made by replacing the usual eye at the end of the weight with an eye welded midway of the counterweight shell.

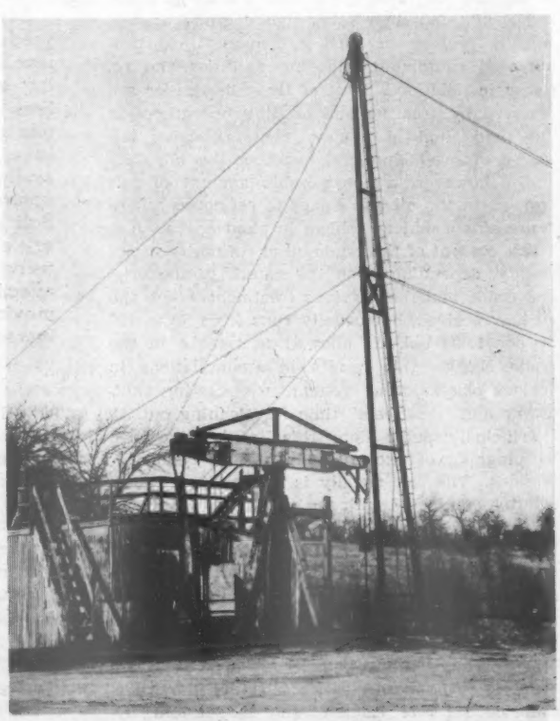
Fire Cart Kept at Tank Battery

To provide the maximum protection against fires, a major operator in Illinois and Indiana maintains a fire-extinguisher cart at each tank battery and separator installation. The installation shown is located in the

Wabash River bottoms, where the equipment is mounted on platforms elevated above the high-water level. Sides of the ramp frame serve as tracks for the wheels of the cart when it is rolled on or off the platform.

Wooden Walking Beams Return

Scarcity of steel is prompting some operators to return to use of wooden walking beams in pumping units. In the installation shown, which is on a well in the Semi-



nole, Okla., area, the wooden walking beam is reinforced with a frame constructed of pieces of old tubing. The frame is bolted to the beam. Wooden stairways also are used to save steel. The pulling mast is constructed from reclaimed pipe.

Manifold Built for Needs Of Large Pump Station

By PAUL REED

MANIFOLDS at pump stations of Magnolia Pipe Line Co. have been constructed to meet requirements determined by operating conditions affecting piping systems in crude-oil service. An example of what the company has done to improve the type of equipment used for this important part of station facilities may be observed at a large station where crude is received by trunk line from several producing areas and where connections are provided for pumping to a nearby refinery as well as to other trunk lines.

This manifold has been designed so that in addition to facilitating repairs and possible future enlargement, provision has been made for insuring correct alignment and to relieve stresses due to temperature changes as well as for safe and convenient working conditions under which samples are taken and scrapers are handled.

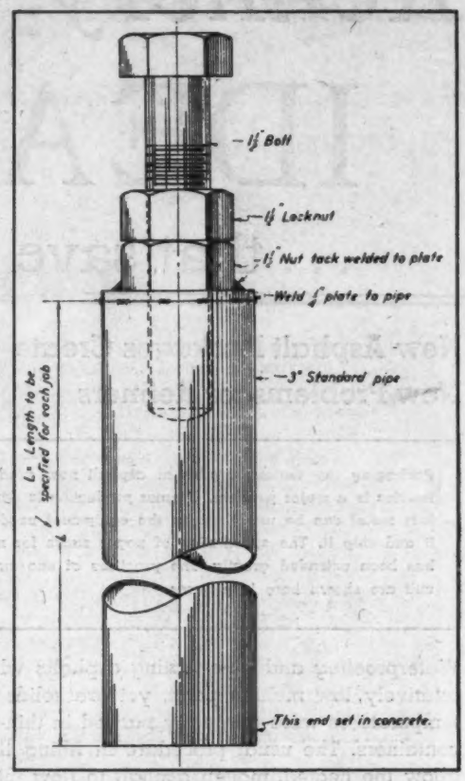
There is sufficient space between manifold barrels to furnish room for connection work which may be necessary from time to time. Valves adjacent to grating walkways are placed with valve wheels lined up diagonally so that they may be in a position suitable for convenient handling by operators. Headers are designed with blind flanges at convenient points to allow for future enlargement.

The shed over the manifold pit is constructed on a frame made largely of old 2-in. and 4-in. pipe. The roof is corrugated galvanized iron. Since the shed has no side walls there is ample ventilation. The manifold pit is kept spotlessly clean.

Special features of the manifold are devices used for maintaining correct alignment. Rollers are used for the various footings so that the entire manifold assembly may move as required for temperature changes. In this way stresses, which may even affect pumping machinery adversely, are relieved effectively. These rollers are made of extra heavy 3-in. pipe placed on elevated concrete slabs. To check the weight and keep the necessary alignment of long discharge lines they are supported at certain points by special jacking devices made for this purpose. Adjustments can be effected by turning a nut with a wrench. By jacking up the piping accurately to the correct position, beneficial results have been obtained which have been advantageous to the entire manifold.

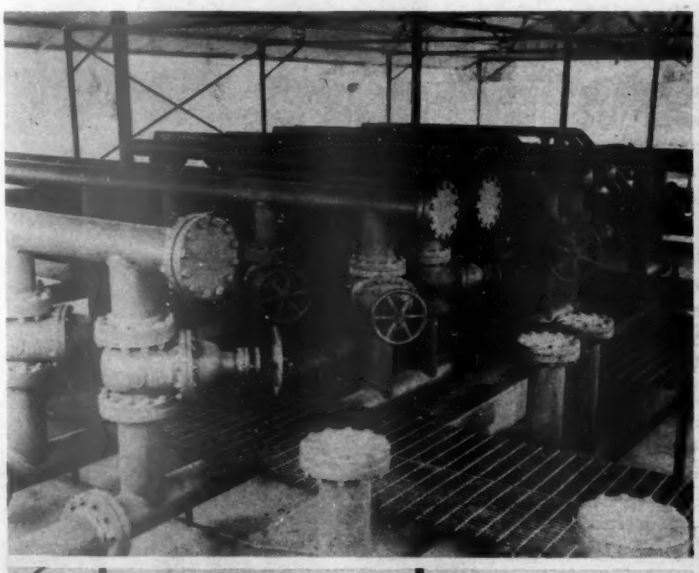
Particular attention has been given to fittings used for sampling and gage-line connections. Outside the ½-in. riser for taking samples or for gage-line connections, there is a 1¼-in. nipple which is welded to the large pipe. The 1¼-in. nipple is threaded at the upper end. If, by accident, the smaller riser should be broken off, the 1¼-in. nipple could be easily closed by screwing on a cap or used as a new connection for gage lines and sampling lines. The ½-in. sampling riser is equipped with valve and swing connections.

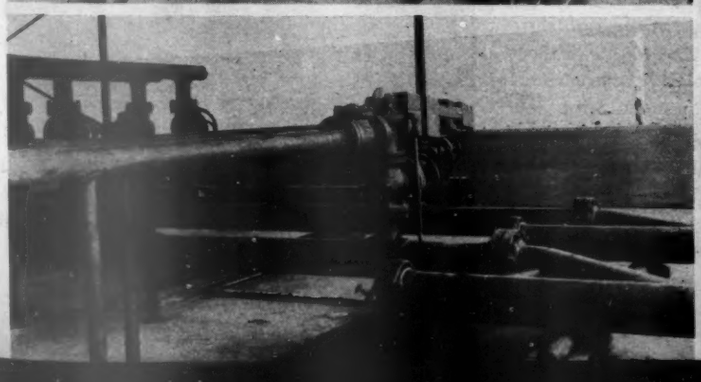
Scrapers are handled through a specially fabricated Y-shaped piping arrangement. A C.R.C. scraper-trap coupling is used in order to insert the scraper in the line and this device can be removed more readily than a blind flange; in general appearance it has some resemblance to artillery breech-block mechanism.

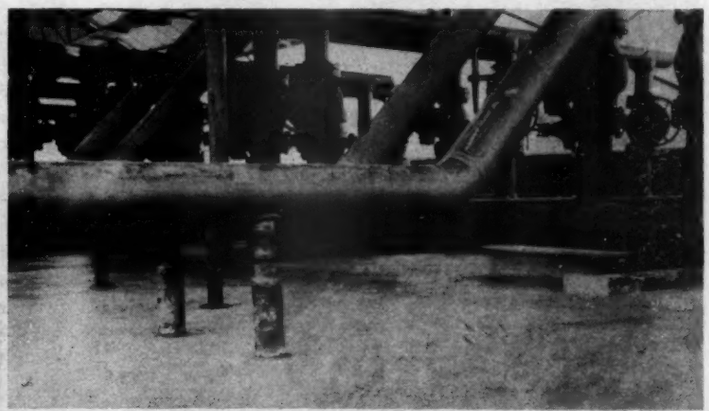

1½" Bolt
1½" Locknut
1½" Nut tack welded to plate
Weld ¼" plate to pipe
3" Standard pipe
L= Length to be specified for each job
This end set in concrete.

Standard crosshead-guide support

Top, left: The manifold has been planned for convenience in operation and connection work. Bottom, left: View shows rollers for footings for manifold. In the foreground is a relief valve. Top, right: Jacking devices, installed as permanent part of manifold, maintain correct alignment. Bottom, right: Scraper traps and sampling devices







Refinery IDEAS

. . . that save $ $ $

New Asphalt Packages Create New Problems for Refiners

Packaging the various grades of asphalt now produced in refineries is a major problem. Greater production is demanded but less metal can be used both in the equipment needed to make it and ship it. The substitution of paper sacks for metal drums has been extended greatly. The practices of one small refining unit are shown here in pictures.

Waterproofing and pipe-coating asphalts which have a relatively low melting point, yet are solids at ordinary temperatures were originally packed in thin-walled steel containers. The usual procedure in filling these was to allow the heated, molten asphalt to flow into the metal container and then after cooling and solidifying, the con-

tainer was shipped to the consumer who split the container and solid asphalt to pieces. Practically all of the metal was buried or wasted in some manner. Now, with metals scarce and fiber board found to be a suitable substitute here, this refiner is utilizing the latter. In this picture, the top of the fiber carton is being shaped and stitched and with the rounded, fiber bottom in place. To this the sides are being fastened. Next, the molten asphalt will be poured into the carton and allowed to solidify. After this, the other end of the carton will be closed by folding and stapling.

After the roofing asphalt has been allowed to cool in the fiber carton adopted by this plant as a substitute for steel drums, the opposite end of the carton is closed by folding and the six flaps are then stapled. The finished cartons may be seen in the background while the simple operation of hand-stapling may be judged by studying the position of the operator and the device used.

Under the pressure of shipping maximum quantities of asphalt and wanting to conserve the use of steel in new automatic loading devices, the refiner has devised a four-legged stand to hold the hot hose delivering asphalt to the empty containers. This stand is nothing more than a welded assembly of four legs made from scrap pipe nipples and a short central riser. The top of the riser includes a cross-arm on which the hose rests and to which the hose is wired.

Asphalt which melts at relatively high temperatures is poured hot into paper sacks held in wooden forms for cooling. The rectangular shape of the wooden form is therefore established for the load. The operator at the right has one of the filled, partially cooled sacks which he will stack. Note the rigid, high sides on the wooden form and the handles.

CO$T Engineering

A WEEKLY FEATURE OF THE OIL AND GAS JOURNAL — DRILLING

NOVEMBER 26, 1942

SAVINGS IN BARGE DRILLING

FOR a number of years drilling barges have been employed extentively in the development of waterbed and marsh-located fields on the Gulf Coast. Their use not only has greatly expedited drilling in such locations but has effected substantial savings in well costs as compared with development in which piling or other types of maritime structures are used for drilling.

Savings begin with the elimination of the cost of the foundation structure. In an ordinary piling job, providing foundations for derrick, engines, pipe rack and mud pits and boilers, in protected or semiprotected waters, approximately 260 piles are used. The average cost of these per well is approximately $15, figuring $5 for driving, $5 for pulling, and $5 loss from cutting of ends each time a pile is used.

Figuring $15 per pile for each well, the total cost of 260 piles in the foundation structure would be $3,900. Added to this would be the cost of necessary replacements of bracing timber and bolts, derrick barge time, rig builders' time and boat expense for hauling totaling approximately $1,000.

Not more than 14 piles are needed when a well is drilled with a drilling barge, serving only as guides for the barge. On the same charge basis, these would cost $210 per well, while cost of bracing and bolts do not exceed $100, making a total cost of only $310, as against $3,900 for a piling structure.

Construction of piling foundation usually takes from 25 to 30 days. If the locations are in areas where new locations can be anticipated sufficiently in advance the structure can be erected and completed while the preceding well is drilling. In such instances, a rig can be moved on immediately upon its release from the preceding well, and no waiting time need be computed. However, in most areas on the Gulf Coast, development is a matter of stepping out from production and new locations are controlled by information gained in the preceding well. Consequently, it is not always advisable to prepare a location in advance. In such a case a rig might be tied up pending completion of the foundation, and idle-rig time charges would have to be made against the well, not to mention loss of production by delay in drilling the well.

Except for the driving of not more than 14 piles for guides for the barge, locations do not have to be prepared in advance for drilling barge, hence with use of barges, waiting-time charges are reduced to practically nothing.

In a water or marsh-located field in which drilling barges are not used, the time required for dismantling, moving and reassembling rigs is a major cost charge. Well time for eight representative wells in three water-located areas of South Louisiana which were drilled with piling foundations and which include four wells in favorable locations (where boilers did not have to be moved) and four wells in outlying locations, depths of wells ranging from 4,000 to 6,500 ft., is shown in the following tabulation:

Time—	Total 8 wells (days)	Average time per well (days)
Rigging up	79	10
Drilling	510	64
Tearing down	53	7
Total	642	81

Waiting time while rigs were idle pending completion of foundations on next locations is not included in this table.

It is noted that 132 days out of the total of 642 days were spent in rigging up and tearing down, or approximately 20 per cent of the time, and that the average time per well for these operations was 17 days. Allowing a drilling barge 2 days, which is very generous, for a move a saving of 15 days' time is effected by a drilling barge in a move. On the basis of the above time record for the eight wells, this saving in time of tearing down and setting up a rig would enable a drilling barge to complete 5½ wells per year as against 4½ when piling foundations were used.

When a rig must be torn down and reassembled for each well numerous replacements of tools, nipples, flanges, etc., usually are required. Costs of these sometimes run as high as $1,000 per well. On a drilling barge, on which there is a minimum of disconnecting, replacement costs ordinarily would not exceed $100 per well.

On the basis that more wells can be drilled per year by the barge method, important savings also are effected in fuel costs. Assuming that a barge drills five and one-half wells in a year, the drilling of the same number of wells, based on the above time relationship of 4½ to 5½, would require 466 days if drilled from piling foundations. Allowing 82 days for cement and idle time (55 days for cement and 2 days per well for moves), would use full steam only 299 days for the same number of wells, which would cost $22,425.

The barge in completing wells approximately 18 per cent faster by reason of the greatly reduced time for moves, based on the above comparison, effects an 18 per cent saving in certain drilling costs, namely, labor for rigging up, drilling and tearing down, camp expense, rig builders' time, derrick barge time, apportionment of all boat expense chargeable to the well, etc. The average cost of these items for eight representative wells drilled from piling foundations several years ago was approximately $40,000 (does not include cost of foundations, supervision, overhead, depreciation, well-completion equipment, lease equipment, fuel or water). Deducting 18 per cent, the average cost of the wells if drilled with a barge would have been $32,500, a saving of $7,200.

A summary of the savings which can be effected with a drilling barge in a year, based on the drilling by it of five and one-half wells, is shown in the following tabulation:

Piling:	Piling foundations	Drilling barge
$15 ea., $3,900 per well	$20,350	.....
$15 ea., $210 per well	.....	1,155
Timber:		
$1,000 per well	5,500	.....
$100 per well	.....	550
Tools and fittings:		
$1,000 per well	5,500	.....
$100 per well	.....	550
Fuel and water:		
364 days at $75	27,300	.....
299 days at $75	.....	22,425
Cost of drilling less fuel, water, surface and underground equipment of wells, lease equipment for 5½ wells	219,700	179,080
Total cost 5½ wells	278,350	203,760
Saving by barge	.....	70,590

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CO$T Engineering

A WEEKLY FEATURE OF THE OIL AND GAS JOURNAL

VALUATION

NOVEMBER 26, 1942

CALCULATING ECONOMIC VALUE OF INDIVIDUAL WELL

IN recent months there has been an added incentive to calculate closely the value of an individual well being considered for abandonment. Technically, no well making over 1 bbl. of oil per day can be abandoned without the permission of the OPC and a request or notice must be given on the proper form before the well is plugged. In many cases, it has strengthened the operator's case to supplement the required information with calculations showing how he arrived at the decision to discontinue permanently the particular well.

Logically, abandonment of a well should take place when the revenue equals the expense. Unless something unforeseen happens, such as initiation of repressuring (which requires an added investment) an increase in the price of oil, reduced operating expense or an increase in production, the income from the property will continue to grow smaller. It could be added that in the last few years, and particularly in the last 6 months, the expense has mounted rapidly, and this rise will probably continue.

The basic formula for computing the income from a particular well is simple, mainly because it ignores certain factors or assumes that they are provided for. Normally, it is expressed as follows:

Income = gross income —operating expenses —taxes.

These are, of course, calculated for the working interest which is generally ⅞. However, allowance may have to be made for overriding royalty or free working interest, an oil payment or some other cost which reduces the gross income without an equivalent reduction in expenses.

Theoretically, if the formula shows a negative income, or a loss, the well should be abandoned, but the question is not as simple as this. There are certain lease expenses which will continue after the abandonment of a single well, if these are prorated among the others, a second well may show a loss and so on, until finally all of the wells on a profitable lease may show losses.

Thus abandonment should be definitely decided on only if the well in question is not paying its way regardless of lease expenses and overhead. Between this point and the production level at which the well is paying its full share of all expenses, abandonment depends on numerous other factors.

The level at which abandonment result in a loss of income is determined by substituting the following formula for "expenses":

$$E = \frac{H_w}{H_t}(E_t - E_i - E_p - E_f)$$

Where
H_w = maintenance man-hours charged to the well
H_t = maintenance man-hours charged to lease or subdistrict
E_t = total lease operating expense
E_i = indirect lease operating expense
E_p = direct charge for wage of man operating pumps
E_f = foreman and overhead expense.

This is merely a proportioning of the expense so the well being considered for abandonment is charged with its proper share. The indirect operating expense includes the lease fuel and water systems, roads, and other similar items which might not be appreciably affected by the abandonment of a single well. The same is true of the direct charge for the pumper's wages as it is assumed that he will continue to work; if some labor shift is involved, the equation will need to be adjusted. The expense of the foreman and overhead will likewise continue whether the well is abandoned or not.

If there is a need for the material being used to pump the well (casing, tubing, rods, pumping unit, tanks, etc.) the expense of operation should include a charge of 6 to 8 per cent of the net salvage value of the equipment.

Here again an exception must be made occasionally and it is particularly applicable now. When an operator can save the investment of a large sum of money for new equipment by salvaging wells approaching the economic limit, the material tied up on a stripper property assumes a new value. This has frequently been the case in the past, old wells being abandoned to supply equipment for new wells in normal times. With the present premium on equipment, an operator quite naturally places a high salvage value on equipment tied up in properties supplying only a dribble of oil when the same equiment could be installed at another place and yield more production.

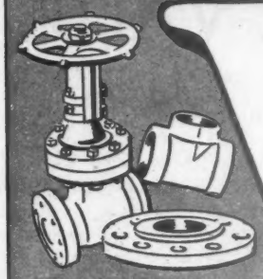
The above does not include pay-roll taxes (old-age and unemployment insurance), old-age retirement carried by many companies, and the ad valorem taxes. It also assumes that the investment has been retired through annual depreciation charges.

Unfortunately, many companies do not have a system for charging these factors back to the lease, or as in the case of taxes, the amount charged to the property is generally known only by the tax department. The ad valorem taxes are an important part of the expense of operating a small property and engineer and superintendent should acquaint themselves with the amounts. In many cases it may be found the property is overtaxed through a high valuation. The men in direct charge of operating the property will have a better idea as to the correct value of the physical assets than will the tax assessor or the tax department.

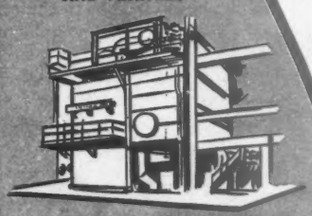
It also is frequently found, on examination by the men operating property that when the taxes are considered, the lease or well is not paying expenses whereas they had previously thought of it as making money. There are a number of such properties which do not show any profit but merely break even after ad valorem taxes are deducted.

There must be some judgment used and latitude allowed in considering the price of the oil. In subnormal times, when the crude market is depressed, a company is justified in continued operation of a lease or well although it temporarily loses money. On the other hand, when the price is reasonably high there is little hope of a further increase in price and a danger of increased operating expense is present, the decision to abandon should be based on the elementary mathematics shown above.

WAR PRODUCTION COMES FIRST!

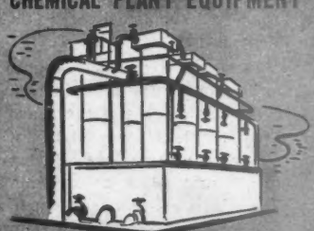


DROP FORGED STEEL VALVES, FITTINGS AND FLANGES

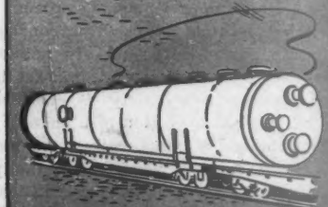


WATER TUBE BOILERS

OIL REFINERY AND CHEMICAL PLANT EQUIPMENT



REFRIGERATION EQUIPMENT



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Engineering Fundamentals

A WEEKLY FEATURE OF THE OIL AND GAS JOURNAL No. 53

NOVEMBER 28, 1942

INDICATOR CHECKS STEAM ENGINE VALVE OPERATION

As mentioned in earlier discussion, the engine indicator may be used not only to check the success of valve setting for either equal leads or equal cutoffs, but also may be used in a cut-and-try manner to set valves without following the two procedures already outlined.

By observing points of admission, cutoff, release and compression on the indicator diagrams, any major faults in valve setting can be determined by the experienced observer. These four events were discussed, in so far as valve position is concerned, in Installment 49. However, the recognition of such events on indicator diagrams was not discussed. Fig. 1 is a hypothetical indicator diagram on which the four important events are shown. The diagram may represent one taken from either the head end or the crank end of a steam-engine cylinder when the valve setting is normal. The point *A* represents the point of admission of live steam into the cylinder as described in connection with Fig. 1 of Installment 49. The point is recognized by the sudden change in slope of the diagram due to the more rapid rise in pressure caused by entrance of live steam into the cylinder space.

Live steam is being admitted to the cylinder throughout travel of the piston a distance proportional to the horizontal distance between points *A* and *B* on the diagram (Fig. 1). At

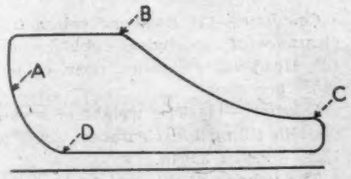

Fig. 1

point *B*, cutoff occurs as described in connection with Fig. 2, Installment 49. That cutoff occurred at *B* is recognizable by examination of the card, due to the noticeable drop in pressure beginning at this point. Expansion of the steam is represented between points *B* and *C*. At point *C* the exhaust port is uncovered by the valve and a sudden drop in pressure is registered by the indicator, so this is the point of release as illustrated in Fig. 3 of Installment 49.

Exhaust of steam, from the end of the cylinder for which the diagram of Fig. 1 was taken, occurred between points *C* and *D*. At point *D* the exhaust port was covered by the valve so that compression of the steam remaining in the clearance space of the engine began at this point. Thus, point *D* represents the point of compression on the diagram corresponding to the valve position illustrated in Fig. 4 of Installment 49. Compression of the steam continues until the intake port is again uncovered to admit new steam as represented by point *A*.

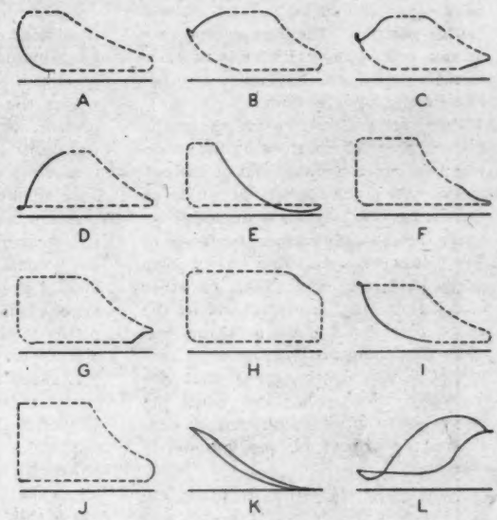

Fig. 2

Diagrams showing indications of improper valve adjustment are illustrated in Fig. 2. Principal causes of irregularities in each case are as follows:

1. Admission too early.
2. Admission late with compression.
3. Admission and release late.
4. Admission late without compression.
5. Cutoff too early.
6. Release too early.
7. Release too late.
8. Cutoff too late.
9. Compression too early.
10. Compression too late.
11. Eccentric too far ahead.
12. Eccentric too far behind.

A knowledge of the meaning of irregularities on indicator diagrams, coupled with an understanding of the effects of changing valve-rod length and eccentric position should enable one to detect and remove the faulty conditions of valve adjustment. The effect of changing the angle of advance (moving essentric on shaft) and of changing the valve-rod length are listed in Table 1.

The method of reasoning followed in adjusting valves from study of indicator diagrams may consist of listing, from examination of both crank-end and head-end diagrams whether each of the four events (admission, cutoff, release, and compression) occur late or early. With the faults of both ends briefly summed up in this way, it should be rather easy to decide by referring to Table 1, what adjustment can be made to correct faults.

TABLE 1

	Effect of increasing			
	Angle of advance		Length of valve rod	
ON—	Head end	Crank end	Head end	Crank end
Admission	Earlier	Earlier	Later	Earlier
Cutoff	Earlier	Earlier	Earlier	Later
Release	Earlier	Earlier	Earlier	Later
Compression	Earlier	Earlier	Later	Earlier

Series prepared by Glenn M. Stearns, associate professor of petroleum engineering, University of Oklahoma

Engineering Fundamentals

A WEEKLY FEATURE OF THE OIL AND GAS JOURNAL

No. 54

NOVEMBER 26, 1942

ENGINE CYLINDER CLEARANCE

THE term *linear clearance* in connection with a reciprocating engine refers to the least distance between the piston and the cylinder head when the piston is at the dead-center position. The linear clearance on one end of the cylinder is not necessarily equal to that on the other end of the same cylinder.

Volumetric clearance refers to the volume of space occupied by the working medium on a given end of the cylinder when the piston is on dead center for that end. It includes all space bounded by inner surfaces of the piston face, cylinder head, valve ports, indicator connections, or other attachments that add volume to the space occupied by the working medium when the piston is at dead center. Cylinder drain pipes that are normally filled with water when the engine is running should not be considered as a part of the volumetric clearance.

Volumetric clearance is often expressed as a per cent of the displacement volume of the engine and spoken of as *clearance ratio* or *per cent of clearance*. Linear clearance does not, in general, enter into calculations but its determination may be necessary in connection with certain mechanical work on the engines.

In certain considerations, particularly when using the engine indicator, it is desirable to know the volumetric clearance of the engine with which one is working. In working with gas or air compressors, the clearance enters directly into many of the calculations of compressor capacity, volumetric efficiency, horsepower, and other important relationships. The method described herein as applied to steam engines can be also adapted to measurement of the clearance volume of compressors and other similar reciprocating machines.

If an engine is not too large, its head-end linear clearance may be determined by the following procedure:

1. Set engine on head-end dead center. (See Installment 48.)
2. Place matching marks on crosshead and crosshead guide.
3. Detach connecting rod from crosshead.
4. Push crosshead and piston toward head end until piston contacts with cylinder head.
5. Measure distance that mark on crosshead has moved from mark on guide. This measurement will represent the linear clearance.

By a similar procedure, crank-end linear clearance may be determined.

When dealing with larger engines, the linear clearance may be measured by removing the cylinder-head cover, placing a piece of putty on the piston where the least clearance appears to be, replacing the cylinder-head cover tightly with engine on dead center, removing cover, and measuring the least thickness of the squeezed putty.

A method that may be applied to the measurement of volumetric clearance consists of measuring the volume of water required to fill the clearance space of the engine when the piston is at dead-center position. This method may be outlined as follows:

1. Place engine accurately on dead center for one end by the method described in Installment 48.
2. Make steam valves leakproof either by applying grease or heavy oil to the seating surfaces or by placing a thin gasket between the valve and its seat.
3. Apply grease or heavy oil to the contact between the piston and cylinder wall to prevent leakage past the piston.
4. Introduce water through indicator connection or other opening at top of cylinder, weighing or measuring water before and after in order to determine amount added.

If the water is measured by weighing, it should be reasonably pure so its density will agree with that obtained for pure water at the existing temperature from water density tables. The weight of water, in pounds, required to fill the space divided by the density of water in pounds per cubic inch, at the temperature existing in the water-filled space will give the volumetric clearance in cubic inches. The density of water may be taken as 0.0361 lb. per cu. in. at 60° F.

Particular precautions should be observed to prevent leakage through the valves or past the piston, when using the above-described method. A check should be made for leakage by observing if the water level drops after a few minutes of setting in the cylinder. If so, a leak is indicated and the test should be repeated after the leak has been sealed. Precautions should be taken not to use excess sealing material sufficiently to materially affect the volume of the clearance space.

It is important, also, to take precautions to prevent the trapping of air in certain irregular parts of the clearance space when applying the water-measurement method. If such air pockets cannot be prevented, it may be possible to blank them off and measure their volume by other methods. For example, an irregular space might be filled by pressing putty into it so that no air would be trapped, the remaining clearance space measured with the putty in place, and finally the volume of the putty measured by water displacement in a graduated cylinder and its volume added to the first volume obtained.

If the *clearance ratio* is desired, the piston displacement must be known. The displacement may be determined by measuring the bore of the cylinder with inside calipers, determining the stroke length by measuring the travel of a reference mark on the engine crosshead when the engine is moved from one dead-center position to the other, and using these two measurements in calculations.

Problem: The following data were taken on a test to determine volumetric clearance of the head end of an engine by the water measurement method:

Weight of bucket and water before filling, pounds	13.30
Weight of bucket and water after filling, pounds	9.40
Displaced volume of putty used to prevent trapping of air, cubic centimeters	35
Engine bore, inches	12
Piston stroke, inches	14

Calculate.—(1) Head-end volumetric clearance of the engine, cubic inches. (2) Head-end clearance ratio of engine, per cent.

Solution.—(1) The weight of water used in filling the clearance space is 13.3 — 9.4 = 3.9 lb.

The volume of this weight of water is 3.9/0.0361, or 108.0 cu. in.

1 cu. in. = 16.39 cc.

Then the volume of the head-end clearance space is 108.0 + 36/16.39 = 108.0 + 2.1 = 110.1 cu. in.

(2) The head-end displacement of the engine is:

$$D = \frac{\pi(12)^2(14)}{(4)} = 1583.3 \text{ cu. in.}$$

Then, the head-end clearance ratio is obtained as follows:

$c = 110.1/1583.3 = 0.0695$, or 6.95%

Series prepared by Glenn M. Stearns, associate professor of petroleum engineering, University of Oklahoma

REFINERY ACTIVITY AND EXPANSION

Crown Central Authorized To Increase Texas Outlay

WASHINGTON, D. C.—Commitment of the Defense Plant Corp. to the Crown Central Petroleum Corp., Baltimore, Md., for installation of additional facilities at the company's Texas Gulf Coast refinery was increased $900,000 to a new total of more than $7,000,000.

Crown Central will operate the facilities under contract with the Defense Plant Corp., which will retain title to the equipment.

Crown Central is one of three petroleum refiners commissioned to supply raw material for the synthetic-rubber plant now under construction by Sinclair Rubber, Inc.

Imperial Oil Subsidiary to Operate Rubber Plant

SARNIA, Ont.—St. Clair Processing Corp., Ltd., recently incorporated as a subsidiary of Imperial Oil, Ltd., is the third Canadian concern formed for the purpose of operating units of synthetic plants being built by Polymer Corp., Ltd., as part of the Dominion Government's rubber program. The new corporation will operate the butadiene and butyl-rubber plants at Sarnia for Polymer Corp.

The styrene plant will be operated by Dow Chemical Co. of Midland, Mich. The polymerization plant will be operated by Canadian Synthetic Rubber, Ltd., which is owned jointly by Dominion Rubber Co., Ltd., the Goodyear Tire & Rubber Co. of Canada, Ltd., Firestone Tire & Rubber Co. of Canada, Ltd., and the B. F. Goodrich Rubber Co. of Canada, Ltd.

Officers of St. Clair Processing Corp. are: L. C. McCloskey, president; F. P. Dawson, vice president; F. C. Lantz, Dr. R. K. Stratford, C. E. Carson, and O. L. Macpherson, directors; A. P. Mechin, secretary; George Brydon, assistant secretary and treasurer. F. C. Lantz is manager of the company.

Douglas' California Refinery Sold for Lend-Lease Aid to U.S.S.R.

LOS ANGELES, Calif.—Sale of Douglas Oil & Refining Co.'s 10,000-bbl. plant between Los Angeles and Wilmington, Calif., to the U.S.S.R., on a lend-lease arrangement was confirmed in Washington, D. C., this week. The plant was sold to the U. S. Treasury Department which has arranged to dismantle the refinery and ship it to Soviet Russia.

The Douglas refinery, commissioned about the middle of 1941, has capacity of 10,000 bbl. daily. The cracking unit is designed to process approximately 9,000 bbl. per day of 17-gravity reduced crude, yielding about 3,300 bbl. of 400-end point 10-lb. gasoline. The distillation unit was designed to process 9,000 to 10,000 bbl. per day of 25-gravity mixed-base crude.

The refinery was constructed by the Fluor Corp. of Los Angeles and was licensed by Universal Oil Products Co. Engineers provided for optional installation of additional facilities at practically all stages of processing in designing the plant. This flexibility inherent in the original plant layout is one of the features making it particularly well suited for removal to Russia where it will be installed in a protected part of the country and operated to produce war fuels.

Donald W. Douglas, president of Douglas Aircraft Co., is chairman of the board of the refining company. George W. Stra'ton, president of Douglas Oil & Refining Co., is in Washington consummating details.

Phillips' Isoversion Process Boosts Fuel, Rubber Output

A new catalytic process, Isoversion, which will increase markedly the production of 100-octane number aviation fuel and synthetic rubber is announced by Frank Phillips, chairman of the board of Phillips Petroleum Co.

The process converts petroleum products hitherto unusable in making war products into products which are vital to the manufacture of aviation fuels and synthetic rubber, Mr. Phillips said.

Sketches of Plant Operators . . .

J. BLOUNT MULL, manager of refining for Cosden Petroleum Corp., Big Spring, Tex., has 2 years of practical experience with shale oil operations in the background of his career in the event the industry is turned to that reserve for supplies.

Meanwhile, Mr. Mull relies more heavily on nearly 19 years spent in petroleum-refinery operations for successful prosecution of his present assignment.

Born and educated in Indiana, Mr. Mull graduated in 1921 from Purdue University with a degree in chemical engineering. The following year he continued graduate work at the Colorado School of Mines, specializing in petroleum chemistry and geology.

He became interested in oil shale through the late Victor C. Alderson, president of the school of mines and a leading advocate of commercial development of the oil shale deposits of our western states. In September 1922 this interest led to a position at the large experimental plant of Catlin Shale Products Co., largest American producer of shale oil at Elko, Nev. He served successively as plant-shift foreman and assistant chief chemist until the operation was abandoned late in 1924 after about 7 years of experimentation. The rapid drop in crude-oil prices following World War I discouraged expansion to full commercial scale.

For the next 1½ years he was a chemist at the Parco, Wyo., refinery of the Producers & Refiners Corp., resigning in 1925 to accept a position with Roxana Petroleum Corp. which developed into a 14-year association with the Shell organization.

After a 2-year preliminary period as assistant chief chemist, he served as chief chemist and head of the treating department and acid recovery plant at the East Chicago refinery for 4½ years. In January 1933 he was promoted to the position of refinery technologist in the home office manufacturing department where he served until September 1940, when the St. Louis office was closed and its functions merged with the New York headquarters.

On September 9, 1940, he joined Cosden Petroleum Corp. as refinery technologist at the Big Spring home office. On April 1, 1942, he was promoted to manager of refining, his present position.

Next to his work, his principal hobbies are: (1) his family consisting of a Wyoming wife, a 7-year-old son, and a daughter of 5; (2) photography, and (3) collecting books, especially early Americana on the West and Southwest.

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Bound to secrecy by censorship regulations and therefore unable to release any specific data regarding the details of the process or its products, Mr. Phillips emphasized the fact that the development of this process to a commercial success is still better insurance against any possible shortage in the production of these vital war materials, consumption of which is increasing rapidly.

Caribbean Area Refining Committee Organized by OPC

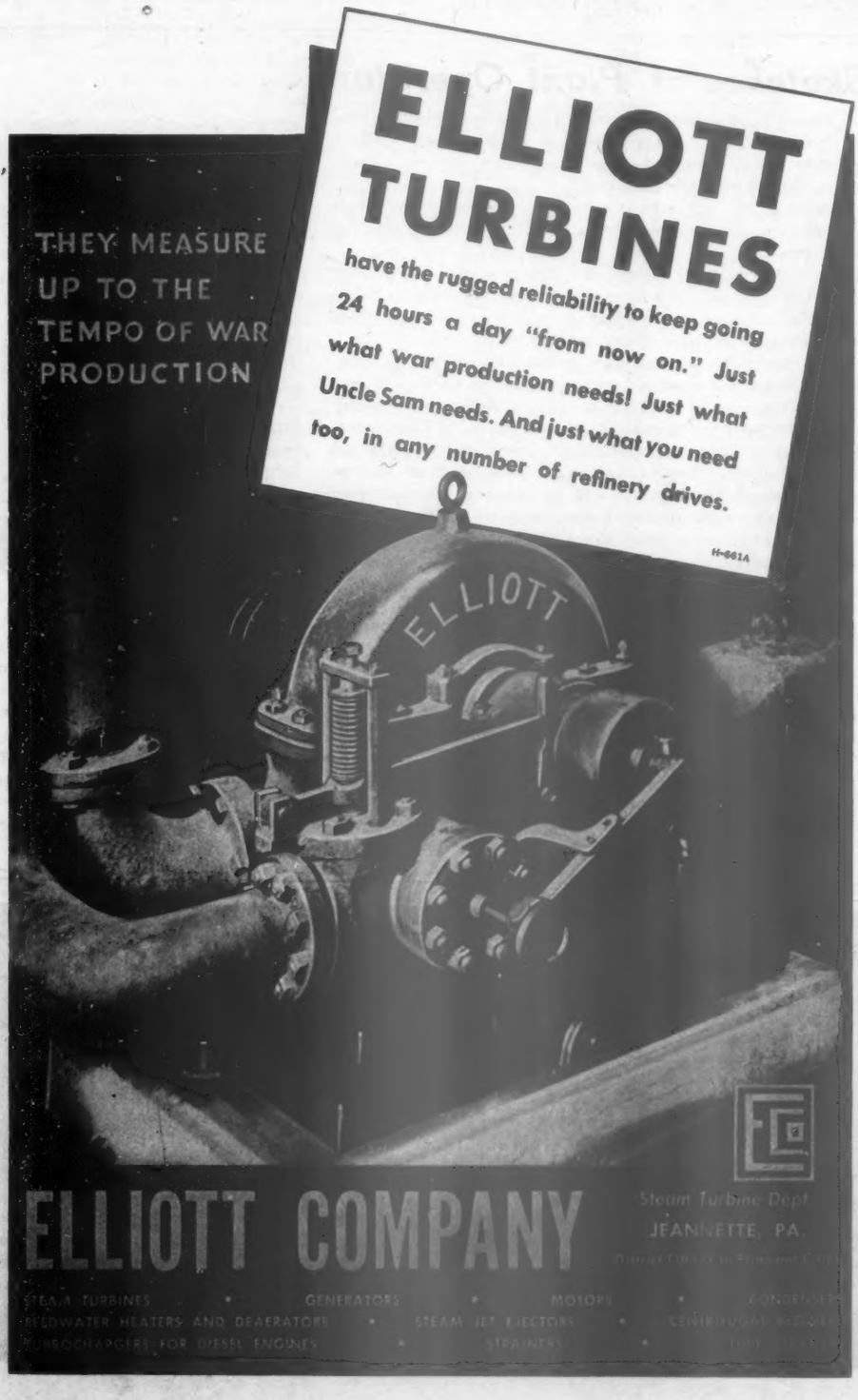
WASHINGTON, D. C.—A "Caribbean Area Refining Committee" has been set up by the Office of Petroleum Coordinator under Plan 24, to organize refining activities in such a way that Caribbean plants will be able to provide the right products at the right time for the war effort.

In announcing the setup of the committee, OPC said it was organized "because of the necessity for the manufacture of petroleum products essential for the conduct of the war, and because of interruptions in the movement of petroleum products from refineries in the Caribbean area as a result of enemy action, the refining activities of companies operating in the Caribbean area have been seriously interfered with."

The new committee has been set up to alleviate this situation and to provide for the maximum production of high-octane gasoline and other petroleum products essential to the war effort and for the most efficient use of raw materials.

The first step in the committee's program, as directed by OPC, is the preparation of " a survey of refining facilities in the Netherlands West Indies, Trinidad, Venezuela and Colombia for presentation to the executive committee of the foreign operations committee in order to determine the output by each refinery of petroleum products essential to the conduct of the war. . . ."

The committee is also empowered to arrange for pooling of petroleum products in the Caribbean area, in much the same manner as they are now pooled in the eastern United States.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Rating of AA-5 Now Needed to Acquire Chrome Steels

WASHINGTON, D. C.—Refiners and other users of corrosion or heat-resistant chrome steel may now get it on a preference rating of AA-5 or higher, but not otherwise, War Production Board has announced.

In amending Order M-21-d, WPB asserted that such steel is now only usable on a rating of AA-5 or higher.

Previously the order permitted the delivery of chrome steel on preference ratings of A-1-k or higher. The amended order makes an exception for use and delivery of chrome steel when acquired before November 18 on preference rating of A-1-k or higher.

The amendment does not affect other WPB orders and regulations which contain restrictive provisions relating to the use and delivery of steel, namely Orders M-21, M-21-a, N-126, and Priorities Regulation 12.

Chemical Industry to Surpass Nature in Rubber Production In One Twenty-fifth the Time

ST. LOUIS, Mo.—The half century it took the natural rubber industry to reach an annual production of 600,000 tons will be duplicated in one-twenty-fifth the time by the chemical industry in providing 1,100,000 tons of synthetic rubber by 1944, Dr. Charles Allen Thomas of Dayton, Ohio, director of the central research laboratories of Monsanto Chemical Co., said last week at a meeting here of 1,800 executives representing a cross-section of American industry.

"Under wartime urgency, the chemical industry has been called upon to supply, in less than 2 years, enormous quantities of synthetic rubber raw materials. The goal is 1,106,000 tons by January 1944, and the job will be done," Dr. Thomas, a recognized authority in the field, told his audience.

"After the war, instead of natural rubber alone, we shall have numerous chemical elastomers to fit specific needs. These elastomers will all be test-tube creations, each tailored to order, and I confidently predict that synthetic rubbers will capture a great many markets in which the natural product formerly enjoyed an unchallenged monopoly."

Michigan Officials Deny Refiners Burning Gasoline

MOUNT PLEASANT, Mich.—Rumors were heard in Michigan that refiners have been burning large amounts of gasoline because reduced auto travel has cut consumption.

"There appears to be no basis for these reports," P. J. Hoffmaster, state supervisor of wells, declared, and F. R. Frye, state petroleum engineer, confirmed the statement but added "if refiners can't make sufficient adjustments to gasoline rationing they may have trouble disposing of their motor-fuel production later on."

Michigan refiners, Mr. Frye said, produce less gasoline than the national average, making more fuel oil. The industry has been pressed for months for greater fuel-oil output, he declared.

Reducing Refinery "Offstream" Time By Desalting of Crudes

(Continued from Page 149)

tion from the oil. These methods, which have been followed principally in the fields, involve the use of heaters, chemicals, electric precipitators or various combinations of these. Methods involving "washing" the oil with heated water with which the released brine droplets readily coalesce and which can be separated by gravity from the oil have been found effective in some refinery desalting operations.

A new method, particularly adaptable to desalting operations in refineries recently has been developed by Dan W. Vinson, Monarch Refineries, Inc., Oklahoma City, Okla., following several years of experimental work carried on through the cooperation of, although not for the Deep Rock Oil Corp., at the latter's Cushing refinery.

In this process, which also embraces "washing" the emulsion crude is heated and mixed with hot water under a turbulent flowing condition, created by intermittent injection of air or other fluid. Temperature of heated oil-emulsion stream is kept well under the evaporating point of the light ends of the oil but is sufficiently high to thin the emulsifying films encasing the brine droplets and the waxy covering of the suspended salt crystals. The relatively clean hot water, which mixes with the heated oil emulsion, facilitates coalescence of the brine droplets and salt particles when the films enclosing them are broken. Intermittent injection of air or other fluid into the flowing mixture of water and emulsion imparts shocks that effect alternate compression and expansion of the dispersed droplets, and the aeration and turbulence created by jets of fluid combine to cause the droplets to shatter their films and coalesce. There is a continued vibration along the path of the mixture which aids the droplets in coalescing with the surplus water added to the emulsion and prevents reforming of the droplets. This also frees suspended salt particles contained in the oil from the oil so that the salts precipitate from the oil and pass off in solution with the water.

The "clean" or fresh water, which may contain 12 to 18 per cent recycle having less than 10 per cent saturation, and the oil emulsion are drawn from their respective tanks through separate heaters, from which the two streams are pumped in separate lines to a mixing chamber in the base of the desalter column. There, they are discharged against each other to mix thoroughly the hot oil emulsion and the water. The heaters may be of any suitable type but preferably consist of drum mounted on a firebox. Temperatures of both streams are maintained approximately the same at a point preferably not exceeding 190° F., depending somewhat on the oil and the emulsion. Meters and flow controls regulate the volumes and proportions of the oil emulsion and water flow through the heaters to the mixing chamber.

The mixing chamber extends coaxially through the bottom of the desalting column, or gun barrel, into a hood having a closed top, whereby the mixture forced against the top is turned back for reverse flow through the annular space in the bottom of the hood about the lower portion of the mixing chamber and through orifices in the lower portion of the hood into the lower portion of the main column. Orifices are downwardly and outwardly inclined and the bottom of the tower concaved to reverse the direction of the flow of fluid upward into the tower.

Path of Flow Is Tortuous

For handling up to 15,000 bbl. daily, the desalting column is approximately 22 ft. high and 20 in. in diameter, the hood of the mixing chamber in the base being 34 in. high and 10 in. in diameter. In the column above the hood are 14 baffle plates, evenly spaced, each containing twenty 1⅛-in. smooth-beveled holes. Holes in the bottom plate and each alternate plate are closely bored in the center. Holes in the intervening plates are bored around the outer edge. This provides a tortuous path of fluid flow upward through the column, assisting in the intimate contacting of the water and the emulsion.

Both the hot water and hot oil-emulsion streams are pumped to the mixing chamber through 4-in. lines. The water line is reduced to ¾ in. at the point of convergence to increase the force of the impact of the water stream against the oil flow. Just ahead of the point of convergence with the water stream, compressed air or gas is injected into the oil stream through a check valve in intermittent jets of about 375 impulses per minute. This livens the oil-emulsion stream and adds to the impact to create more complete mixing. A compressor having a crank-actuated piston is provided for this purpose. Back pressure in the column is maintained by regulator controls at the top. Ordinarily only sufficient pressure to insure flow of the fluid to the top is required, although for tighter emulsions pressures up to 90 lb. may be desirable.

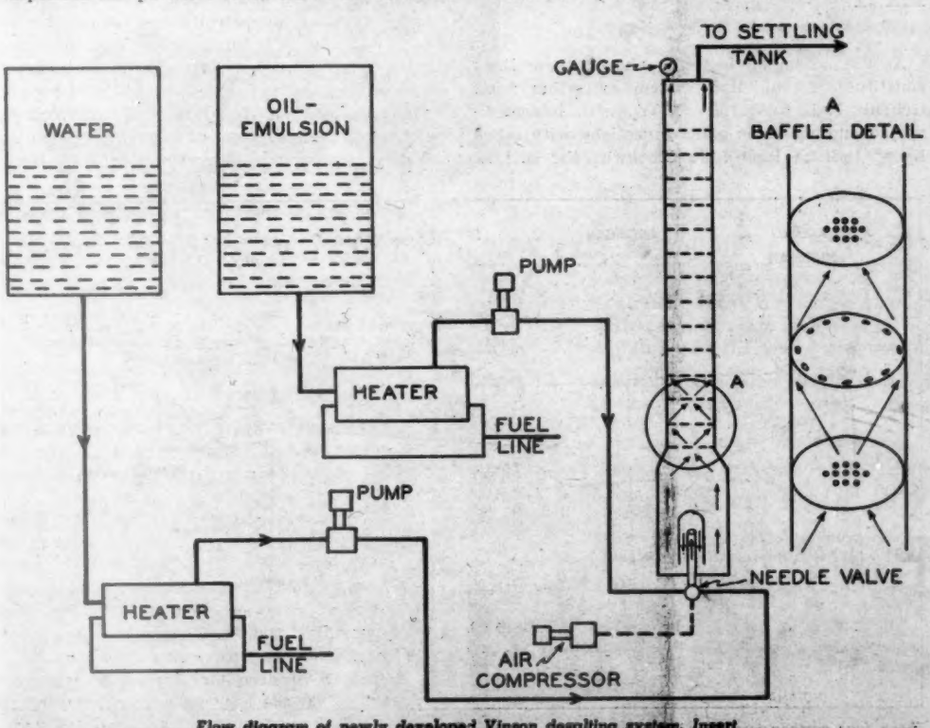
Leaving the top of the tower, the treated mixture is delivered to a settling tank for final separation of the water and salt solution from the oil. Any available settling tank can be used but one having sufficient capacity to insure crude charge supply for 2 to 3 hours of refinery operation is preferable. This provides time for complete settling of the water and salt with a continuous flow of oil to the refinery. It is known that approximately 75 per cent of the water and salt settles in the first 10 minutes. More effective and rapid separation is effected in a settling tank which is held under about 10 lb. pressure. Baffled courses for the flow also facilitate settling. The separated water is drawn off the bottom of the tank continuously and is recycled with added fresh water until it reaches a salt saturation of about 10 per cent. This materially reduces the required amount of makeup water. Saturation of the water coming into tank from the desalting column will run from 34 to 35 per cent but due to the rapid precipitation of the salt in the tank the saturation of the recycle stream is maintained relatively low, the more highly saturated stream being drawn continuously from another bottom outlet.

Salt Content Cut to Less Than 5 Lb.

In tests, the process has reduced the salt content of crude oil containing 100 lb. of salt per 1,000 bbl. to less than 5 lb. In many instances the content has been reduced to practically zero. In this it is necessary to maintain proper contact and settling temperatures, accurate oil-to-gas-to-water ratios with properly balanced pressures.

Treatment of brine-in-oil emulsions in the fields also has constituted a major problem. Emulsions usually are formed by agitation of the oil and water which are produced together. Component parts of the well fluid consists of free water, free oil and an emulsion which is composed of dispersed droplets of water encased in films of an emulsifying agent. The free oil and free water may be separated easily by gravity but the minute droplets of water of the emulsion do not break the films of the emulsifying agent readily so that they may coalesce with other droplets to form drops of sufficient size to separate from the oil by gravity.

The character of emulsions varies greatly.* Some emulsions are much more stable than others, depending on the size, uniformity and natural character of the particles. Frictional agitation of oil and brine during production results in finer droplets of emulsion, which in turn tends to produce more stable emulsions. The physical state and behavior of salts differ widely with some salts much more soluble than others. All these factors have an important bearing on how difficult the emulsions are to resolve, and the methods to be followed.



Flow diagram of newly developed Vinson desalting system. Insert drawing at right shows design baffles in desalting column

*"Photomicroscopy of Salt in Petroleum," by Lloyd F. Christianson and J. W. Horne, Technical Paper 638, U. S. Bureau of Mines.

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THE OIL AND GAS JOURNAL

Pipe-Line Activity

Merger of Northern Group Strengthens Pipe-Line Systems

NEW YORK.—An integrated system of 6,859 miles of pipe line would be formed by the proposed merger of the Buckeye Pipe Line Co., Indiana Pipe Line Co., Northern Pipe Line Co., and the New York Transit Co. The plan has been approved by the directors of the companies and is now being considered by the stockholders. It is expected to be consummated by January 1, 1943.

The unitized system would consist of 3,480 miles of trunk lines and 3,379 miles of gathering lines. A breakdown of the separate systems as they existed as of August 31, 1942, follows:

	Miles of laid pipe		
Company—	Trunk	Gathering	Total
Buckeye	2,022	3,229	5,251
Indiana	*650	...	*650
Northern	624	....	624
New York	184	150	334
System	*3,480	3,379	*6,859

*Not including certain inactive property not in carrier service.

Recently the traffic of these lines, as result of the development of the Illinois fields and the East Coast shortage, has increased markedly. This is shown in the following table of barrel-miles on the trunk lines (figures in millions of barrel-miles):

Company—	1939	1941	*1942
Buckeye	4,507	10,723	8,175
Indiana	413	501	1,328
Northern	259	1,917	1,680
New York	233	627	495
Total	5,412	13,768	11,678

*Eight-month total.

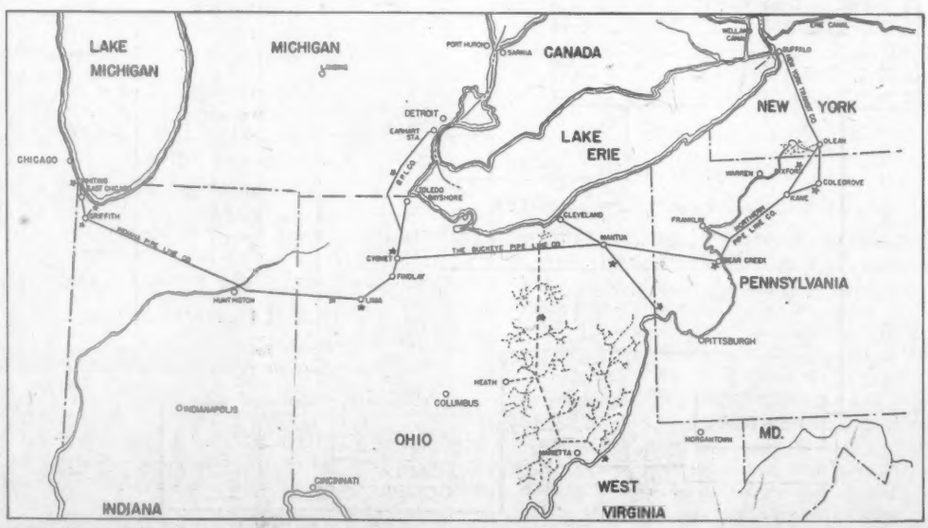
As the accompanying map shows, these lines constitute a trunk-line system extending from Griffith, Ind., to Buffalo, N. Y., with intermediate consuming areas and connections with other lines. Indiana Pipe Line Co. owns the line in northern Indiana from the Chicago area to the Ohio line. Buckeye owns trunk lines in Ohio and Michigan and an extensive gathering system in eastern Ohio. Northern owns trunks connecting with the Buckeye system at the Ohio-Pennsylvania line and extending to the New York border where connection is made with New York Transit which extends to Buffalo. In addition, New York Transit also operates a small gathering system in New York.

These lines have always operated as a system and have been under common management though the directors are different. They were originally part of the old Standard Oil pipe-line system and were disassociated by the 1911 decree, the division being made on the basis of state boundaries.

The plan for unification was recommended by Kuhn, Loeb & Co. In its analysis, the company points out:

"In such matters as the solicitation of business and the negotiation of rates as well as general executive and financial supervision, the companies work together through common executive officers. . . . There are therefore only relatively minor opportunities for further overhead and operating economies in the immediate future but in the opinion of the officers over a period of time unification should result in more efficient use of personnel and property.

"It is our belief that corporate unification . . . will add materially to the strength of the system and its freedom of action in meeting postwar adjustments and the possible future changes in competitive conditions. At present the lines of each of the companies are being used at high capacities as the result of curtailment of oil-tanker movements to the East Coast and the increased demand for petroleum products due to war needs, but it is our opinion that upon the termination of the war emergency, the business of the companies will revert generally to prewar proportions and characteristics, subject, of course, to changes arising from developments such as the construction of the new high-capacity line."



These four northeastern pipe-line systems will be brought under common management and operation if stockholders approve the merger program already sanctioned by boards of the companies

Sinclair May Lay Line From Wood River to Steubenville

According to reports Sinclair interests are considering a project which would entail the construction of a 536-mile, 8-in. pipe line from Wood River, Ill., to Steubenville, Ohio. No information has been received regarding decisions regarding it on the part of OPC and WPB. Pipe would be dug up from loops of the company's trunk lines in the Mid-Continent area. It is possible that a program may be adopted which would call for immediate construction operations. The Sinclair crude-oil system has a terminal at Wood River serving refineries there. A line originally built as a products line from Marcus Hook to Greensburg, Pa., has been in the process of extension to Steubenville. When the project was first planned the intention was to ship westward; the war situation has led to changing the system for shipping eastward.

W. E. P. Has Completed 464 Miles of 24-in. Pipe

The construction of the Texas-Illinois section of the War Emergency Pipelines, Inc., 24-in. crude-oil line is progressing with 464 miles laid at the beginning of this week.

Contract has been let to A. O. Smith Corp. for 280 miles of 24-in. pipe. Contracts for pipe for lines of smaller size have been let to Youngstown Sheet & Tube Co., Republic Steel Corp., and Jones & Laughlin Steel Corp. American Rolling Mill Co. will furnish light-weight pipe for railroad crossings. National Tube Co. is delivering 24-in. pipe at points along the extension route.

Contract has been awarded to A. O. Smith Corp. to furnish factory bends of 2°, 3°, 4° and 5°, varying in length from 2½ to 3 ft. which will be used extensively in the construction of the northern extension of the W.E.P. line. The decision to use factory bends came as a result of the successful operation of Natural Gas Pipeline Co. of America in using factory bends in the construction of the 26-in. loops of last year.

Pipe-Line Personalities . . . . . J. A. Hester

T. A. HESTER, vice president, Oklahoma Contracting Co., was born in 1906 in the vicinity of Tuckerman, Ark., near the route of a section of the 24-in. crude-oil line, now under construction by his firm for War Emergency Pipelines, Inc. He attended the University of Arkansas for 3 years. In 1928 he graduated from Cumberland University with a degree in law and was admitted to the bar in the State of Arkansas the same year.

Mr. Hester entered the employ of Oklahoma Contracting Co. in 1929 as timekeeper. For 5 years he worked for the company as timekeeper, paymaster and assistant foreman. In 1936 he became a gang foreman and the following year he was promoted to the position of general superintendent in charge of construction operations of the organization. At present he is a partner in Oklahoma Contracting Co. which is a successor to the old Oklahoma Contracting Co. of Texas.

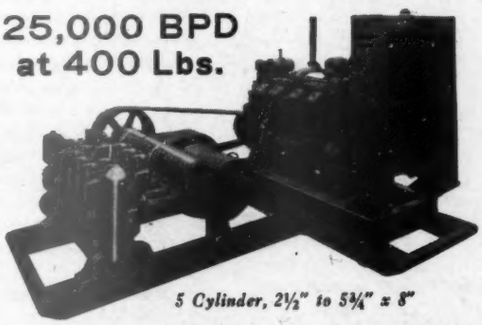
Mr. Hester lives in Dallas, Tex., is married and has one child. Mr. Hester contemplates moving to Pennsylvania in anticipation of his company being awarded contracts for three sections of the extension of the War Emergency Pipelines, Inc., system eastward from Illinois.

Cities Service Gas Co. Builds Line From Blackwell to Burbank, Okla.

Cities Service Gas Co. has begun the construction of 32 miles of 12-in. gas line from the Blackwell, Okla., compressor station on the company system to Burbank, Okla., where the line will connect with the company's system in this field. Part of the gas to be transported through this line will be sold to Phillips Petroleum Co. and the remainder will be transported to the Tallant, Okla., compressor station for delivery into the main transmission system of Cities Service Gas Co. This new line constitutes an important cross-over connection between the west side and the east side of the company's system and because of its importance in serving war production industries the company secured an AA-3 preference rating on the pipe. The company is building the line with its own construction organization and welding will be done by the oxyacetylene method.

Another WHEATLEY—with 5 Cylinders

25,000 BPD at 400 Lbs.



5 Cylinder, 2½" to 5¾" x 8"

WHEATLEY QUINTUPLEX PUMP

Description	Liner	Gals. Per Min.	Bbls. Per Hour	Pressure Per Square Inch	Max. H.P. Req'd
5¾"x8"—V-Belt Drive	3"	109	156	1605	120
Fig. 5830	3½"	154	220	1137	120
Three Cylinder	4"	206	294	850	120
85 R.P.M.	4½"	265	380	658	120
	4¾"	297	424	590	120
	5"	331	473	529	120
	5½"	404	577	434	120
	5¾"	442	631	396	120
5¾"x8"—V-Belt Drive	3"	182	260	1605	200
Fig. 5850	3½"	257	367	1137	200
Five Cylinder	4"	344	492	850	200
85 R.P.M.	4½"	442	632	658	200
	4¾"	495	707	590	200
	5"	552	789	529	200
	5½"	673	961	434	200
	5¾"	735	1050	396	200

For Main Station, Booster Station or Standby Designed for Temporary or Complete Replacement Unit

Just off the assembly line is our most recent development: a pump weighing less than 9500 lbs., capable of developing 1000 bbls. per hour at 400 lbs. pressure, with five individual fluid cylinders and twenty individual valves in pot type fluid cylinder.

LESS WEIGHT SURGE **MORE** VOLUME PRESSURE

- Ten Impulses to One Turn of Crankshaft at 85 r.p.m.
- Reduces Surge Conditions To A Minimum
- Individual and Interchangeable Parts.

Designed to operate as two distinct units if desired, by placing a valve between the set of 3 cylinders and the set of 2 cylinders. These sets can operate with each having a different size liner making it possible for this unit to develop two different pressures at two different volumes.

Interchangeable liners in half-inch graduation from 3" to 5¾" with an 8" stroke, giving wide range of pressure and capacity.

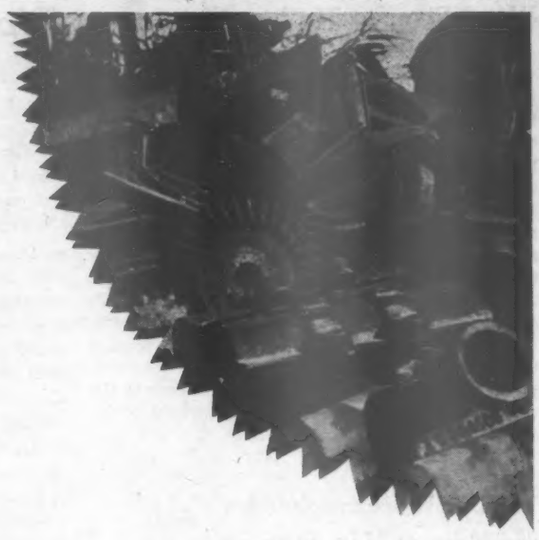
ALSO AVAILABLE IN 3 CYLINDERS (AND A 2½" TO 4" x 6" IN 5 CYLINDERS)

LARGE CAPACITY ● PORTABLE UNIT

Quickly loaded complete with engine on one truck, within highway load, width and height limits. Complete details on application. Write for Bulletin J-526.

WHEATLEY PUMPS *and* VALVES

TULSA, OKLAHOMA



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Fort Worth, Texas

FIELD DEVELOPMENTS...

HIGHLIGHTS FROM THE WEEK'S NEWS—

Despite all of the speeches that have been made regarding the necessity of going out and finding major oil fields, the one activity which could possibly attain results, namely drilling, remains at a low ebb and there seems little possibility that there will be much change in the near future. OPC which suggested 19,000 wells as the objective for this year came extremely close to 100 per cent accuracy in its prediction and is now talking about 15,000 wells in 1943. Of this number, 20 per cent will probably be in the Appalachian district and these will be needed to maintain production there at current levels of about 82,000 bbl. daily. That leaves 12,000 wells for the remainder of the country, or some 230 wells a week.

With only 1 month remaining in 1942, the conclusion that there has been no reversal of the downward trend in exploration is inescapable. As it takes only one wildcat to discover an East Texas, it cannot be said that the trend will not be reversed, but the probabilities are that a reduction in wildcatting will result in a reduction in discoveries. The location of the present exploration implies that the fields which will be found in 1943 will be small, just as they have been for the past 3 years.

Experience in some recent discoveries does not provide much incentive for further development. There are many fields in which production has been cut to fewer than 10 bbl. per well per day following an active drilling campaign extending over 2 or 3 years. These fields have pipe-line connections and many of them have a high quality crude. If the output of these fields is reduced below economic levels, many operators wonder what the advantage is in wildcatting in the same general area.

Another factor which must be borne in mind in appraising the possibilities for large discoveries in 1943 is the heavy or sour crude which many of the best discoveries of 1942 have found. In both East and West Texas, where there has been a good record of success, there is difficulty in disposing of the oil for this reason. It is true that "eventually" this oil will be in demand but many wildcatters are beginning to feel that the wildcat campaign necessary to add materially to the country's reserves should also start "eventually."

The industry and OPC are fully aware of the consequences of further delay but when one agency holds the price of oil down, another will not allow the necessary materials and a third may easily divert idle crews into other activities a crisis is not hard to foresee.

EAST TEXAS: A new Paluxy sand field is indicated in northern Wood County, increasing considerably the probability that a number of other known prospects in the general area which have been found dry in the Woodbine, may produce from the Paluxy sand (p. 175).

CALIFORNIA: Large demand for natural gas for domestic and industrial uses may result in gas fields in Central California going on full production for the first time since their discovery. Standard's prospective gas discovery in Solano County is still uncompleted due to mechanical trouble. A deep test in the Aliso Canyon field of Los Angeles County has cored silty oil sand and may open a new pay for the field (p. 170).

WEST TEXAS: Location has been staked for a deep Ordovician wildcat about 8 miles northwest of Fort Stockton and the first heavy production from the newly found Tubb horizon in the Embar field has been developed. A new pool is in prospect 4 miles southwest of the Wasson field, Gaines County, where a wildcat recovered mud cut with oil and gas during drill-stem tests of the lower Permian (p. 166).

SOUTHWEST TEXAS: A test in Cameron County, the deepest wildcat ever drilled in the Rio Grande Valley, has been abandoned with no shows reported after reaching a depth only slightly below 9,000 ft. Locations have been staked for wildcats in many counties throughout the Southwest Texas district (p. 172).

KANSAS: Arbuckle lime saturation has been found in a Butler County wildcat 2 miles south of the Douglas Lansing-Kansas City lime area, and the Padgett pool, Sumner County, has been extended 1 mile west at its southern tip by a small pumping well completed in the Mississippian chat (p. 179).

OKLAHOMA: A new Prue sand gas field has been opened in southwestern Creek County, about 5 miles south of the Stroud pool. A north offset to the discovery well of the Liberty pool, Noble County, found water in the second Wilcox but was completed as a large flowing well after plugging back to the Avant sand (p. 169).

ILLINOIS: A new Devonian pool in Clinton County and a new Benoist pool in Clay County are reported. A southward extension is in prospect for the new Levias pool on the Jasper-Richland County line (p. 172).

LOUISIANA GULF COAST: A wildcat in La Fourche Parish has been completed as a dry gas well to open the Bully Camp field. An important gas and distillate field is in prospect in Acadia Parish and a Vermilion Parish wildcat has recovered some gas and distillate on a drill-stem test (p. 174).

TEXAS GULF COAST: A new pool has been opened in Jackson County but a Walker County wildcat, 4 miles south of Huntsville, has been completed as a dry hole. A great amount of geophysical work is under way in the Texas Gulf Coast district with at least one crew working in almost every county in the district (p. 176).

COMPLETIONS IN ALL FIELDS . . .

(Week Ending November 21, 1942)

	Oil	Gas	Dry	Total	Footage	Tl. comp. to date 1942	Tl. comp. to date 1941
N. Y., Pa., and W. Va.	49	17	6	72	151,845	3,187	5,352
Ohio	2	7	8	17	45,632	1,037	1,532
Indiana	3	0	6	9	16,718	321	461
Kentucky	0	1	1	2	5,909	230	606
Illinois	34	0	17	51	129,956	1,699	3,286
Michigan	2	0	4	6	13,736	633	820
Kansas	13	2	9	24	72,854	1,413	1,935
Nebraska	0	0	0	0	0	31	76
Missouri, Iowa	0	0	0	0	0	13	33
Oklahoma	12	4	7	23	81,429	1,058	1,685
Texas:							
North Central Texas	4	0	6	10	28,594	992	2,564
West Texas	22	0	5	27	103,408	1,213	2,041
Texas Panhandle	3	0	0	3	9,392	324	617
Eastern Texas	5	0	0	5	25,574	367	944
Texas Gulf Coast	9	0	4	13	91,104	629	972
Southwest Texas	7	0	9	16	90,196	958	1,685
Total Texas	50	0	24	74	349,268	4,483	8,823
North Louisiana	3	3	3	9	34,339	451	700
Louisiana Gulf Coast	1	1	0	2	23,474	429	779
Total Louisiana	4	4	3	11	57,813	880	1,479
Arkansas	2	0	2	4	17,405	167	180
Mississippi and Southeast	0	0	1	1	2,640	70	251
Montana	3	0	0	3	7,524	184	265
Wyoming	3	0	1	4	10,811	102	161
Colorado, Utah	0	0	1	1	1,300	22	29
New Mexico	2	0	1	3	13,086	237	250
California	14	0	2	16	30,753	700	1,006
Total United States	193	33	93	321	1,008,679	16,467	28,230
Total previous week	176	39	103	318			
Week ended Nov. 22, 1941	410	54	129	593			

PERMIAN BASIN, PANHANDLE

Deep Ordovician Test Staked Northwest of Fort Stockton

By W. D. THORN

MIDLAND, Tex.—Gulf Oil Corp. stepped up its search for new reserves in West Texas, in which district it is the dominant producer and proven leaseholder, staking location for a new 8,500-ft. Ordovician wildcat, 1 Rooney Mercantile Co. Location is about 8 miles northwest of Fort Stockton, in an area where little is known about the deeper formations. It is 700 ft. from the north line and 620 ft. from the west line of Section 82, Block OW, C.C.S.D.&R.G.N.G.R.R. Survey, approximately in the center of a 7,000-acre block. It is also about 12 miles south and west of Magnolia 1 Alan Robertson, which continued testing sandy shale formation at the 6,500-ft. level last week, showing a little oil and a salty water. This new Gulf operation makes it the third Ordovician wildcat started by the company in West Texas within the past 60 days, the previous two tests being in Crane County, at 1-A Dawson and 1 Estes, both of which are drilling in the Permian lime section now.

Humble Oil 1 Parker, ¼ mile south of the Abell field, Pecos County, topped the McKee sand, chief Simpson sand pay section in that field, at 5,330 ft. and started coring at 5,340 ft. Phillips Petroleum 1 Price, deep test in south central Pecos County, was drilling below 7,100 ft. with no shows reported.

First heavy production from the newly found Tubb pay zone of the Embar field, Andrews County, was developed last week at Phillips Petroleum 22 University-Andrews, which flowed 259 bbl. of 42.3-gravity oil through ⅛-in. tubing choke on official 24-hour Railroad Commission gage. Gas-oil ratio was 544 to 1. Estimated good for about 1,500 bbl. daily if flowed through open tubing, production was from casing perforations at 6,240-80 ft., after treating with 1,000 gal. of acid. Besides being the biggest well in the field from the Tubb zone, it extended the zone 1¼ miles north, being located in SW SW Section 20, Block 10.

Atlantic Refining et al 1-A Tex-U, in south central Andrews County, was drilling ahead at 10,724 ft. in lime with no shows.

Shell Oil 1 Leaverton, wildcat in Section 458, 4 miles southwest of the Wasson field, Gaines County, showed additional chances of making a lower Permian producer last week. Coring ahead late in the week at 6,900 ft., it had recovered 16½ bbl. of mud cut with oil and gas with no water, on a 60-minute drill-stem test from 6,739-6,860 ft., and on another test at 6,729-6,840 ft. had recovered 85 ft. of oily mud.

Shell Oil Co. 1 W. D. Blue, deep wildcat on the Winkler-Ector County line, was drilling below 7,436 ft. Amon Carter et al 2-C Walton, Keystone field area, was drilling below 5,550 ft. In Crane County, Magnolia's closely watched 1 Tucker was drilling at 5,764 ft., still a couple of hundred feet above the Simpson oil sand found in the 1 Glenn, ¼ mile to the southwest.

WEST TEXAS COMPLETIONS

Fields

Fullerton, Andrews County: Fullerton Oil Co. 4 Wilson, Sec. 15, Blk. A-32, P.S.L. Sur., location abandoned.

Mascho-University, Andrews County: N. G. Penrose 2-A Humble-University, Sec. 3, Blk. 10, University Sur., elev. 3,222 ft., flowed 133 bbl. through ¼-in. choke, pay 4,440 ft., T.D. 4,620 ft.

Emma, Andrews County: Sinclair Prairie 19 Emma Cowden, Sec. 1, Blk. 44, Twp. 2n, T.&P. Sur., elev. 3,162 ft., flowed 870 bbl., pay 4,160 ft., acid 5,000 gal., T.D. 4,250 ft.

Slaughter, Cochran County: Continental Oil 10-58 Dean, Sec. 1, Lge. 58, Martin C.S.L. Sur., elev. 3,685 ft., flowed 811 bbl., pay 4,920 ft., acid 12,000 gal., T.D. 4,967 ft.

J. C. Hawkins 1-A Mallet, Lab. 25, Lge. 47, Edwards C.S.L. Sur., elev. 3,657 ft., flowed 822 bbl., pay 4,930 ft., acid 11,500 gal., T.D. 4,980 ft.

J. C. Hawkins 21-A Mallet, Lab. 16, Lge. 47, Edwards C.S.L. Sur., elev. 3,660 ft., flowed 742 bbl., pay 4,924 ft., acid 12,500 gal., T.D. 4,978 ft.

Magnolia Pet. 5-H Mallet, Lab. 9, Lge. 53, Scurry C.S.L. Sur., elev. 3,626 ft., flowed 344 bbl. through ½-in. choke, pay 5,020 ft., acid 10,500 gal., T.D. 5,040 ft.

Texas Pacific Coal & Oil Co. 2-E Mallet, Lab. 2, Lge. 53, Scurry C.S.L. Sur., elev. 3,652 ft., pumped 222 bbl. plus 3 per cent water, pay 5,000 ft., acid 10,000 gal., shot 140 qt. nitro 5,000-52 ft., T.D. 5,053 ft.

Sand Hills Deep, Crane County: Gulf Oil 44 Waddell et al, Sec. 18, Blk. 3, H.&T.C. Sur., elev. 2,469 ft., flowed 63 bbl. oil plus 61 bbl. water through ¾-in. choke, pay 5,663 ft., acid 2,500 gal., top Ellenburger 5,475 ft., T.D. 5,696 ft.

Sand Hills, Crane County: Magnolia Pet. 17 P. J. Lea, Sec. 4, Blk. 32, P.S.L. Sur., elev. 2,629 ft., flowed 365 bbl. through ½-in. choke, pay 4,451 ft., T.D. 4,673 ft.

World, Crockett County: Garrett M. Smith 1-E Powell, Sec. 6, Blk. A, B.S.&F. Sur., elev. 2,791 ft., pumped 150 bbl. plus 15 per cent water, pay 2,656 ft., acid 500 gal., T.D. 2,669 ft.

Foster, Ector County: Amon G. Carter 1-A J. L. Johnson, Sec. 11, Blk. 43, Twp. 2s, T.&P. Sur., elev. 2,968 ft., pumped 152 bbl., pay 4,040 ft., acid 1,000 gal., T.D. 4,136 ft.

Slaughter, Hockley County: Texas Co. 5 Lucas, Sec. 7, Blk. X, P.S.L. Sur., elev. 3,551 ft., flowed 587 bbl. plus 5 per cent water, pay 4,998 ft., acid 4,500 gal., T.D. 5,031 ft.

Walker, Pecos County: Cardinal Oil Co. 5-B University, Sec. 24, Blk. 16, University Sur., elev. 2,995 ft., flowed 52 bbl., pay 2,092 ft., shot 60 qt. nitro, T.D. 2,120 ft., P.B. 2,107 ft.

Cardinal Oil Co. 2-E University, Sec. 13, Blk. 16, University Sur., elev. 2,974 ft., flowed 72 bbl., pay 2,098 ft., shot 50 qt. nitro 2,098-2,108 ft., T.D. 2,108 ft.

Cardinal Oil Co. 1-L White & Baker, Sec. 90, Blk. 194, G.C.&S.F. Sur., elev. 2,901 ft., flowed 51 bbl., pay 1,914 ft., shot 80 qt. nitro 1,914-32 ft., T.D. 1,932 ft., *(extension)*.

Barnhart, Reagan County: Ogden and Hawn 1-B University, Sec. 9, Blk. 48, University Sur., elev. 2,705 ft., flowed 233 bbl. plus 8 per cent water in 9 hr. through ½-in. choke, pay 9,135 ft., acid 10,000 gal., top Ellenburger 8,995 ft., T.D. 9,246 ft., P.B. 9,200 ft.

McCamey, Upton County: Trebol Oil Co. 4 Ricker, M. S. Denton Sur., Sec. 5, Blk. R, elev. 2,564 ft., flowed 264 bbl. plus 34 per cent water through ½-in. choke, pay 2,116 ft., T.D. 2,210 ft.

Magnolia-Sealy-South, Ward County: Atlantic Ref. et al 1-B University, Sec. 12, Blk. 16, University Sur., elev. 2,644 ft., flowed 389 bbl. through ¼-in. choke, pay 2,907 ft., T.D. 2,911 ft.

Monahans, Ward County: Shell Oil 2 Sealy-Smith Foundation, Sec. 38, Blk. A, G.&M.M.B.&A. Sur., elev. 2,729 ft., flowed 759 bbl. oil plus 26 bbl. water, from casing perfs. 5,633-43 ft., acid 3,500 gal., gas-oil ratio 1,369:1, gravity 34.5°. T.D. 5,741 ft., P.B. 5,660 ft. *(new pay)*.

Wasson field, Yoakum County: American Liberty Oil Co. et al 2 Lynn, Sec. 733, J. H. Gibson Sur., elev. 3,639 ft., flowed 173 bbl., pay 5,070 ft., acid 10,000 gal., T.D. 5,169 ft.

PANHANDLE COMPLETIONS

Carson County: J. M. Huber 14 Burnett "R," Sec. 111, Blk. 5, elev. 3,148 ft., potential 70 bbl., pay 3,072 ft., T.D. 3,125 ft.

Skelly Oil Co. 162 Schafer, Sec. 189, Blk. 3, elev. 3,204 ft., potential 153 bbl., shot 570 qt. nitro 3,050-3,160 ft., T.D. 3,167 ft.

Gray County: Wilcox O. & G. Co. 41 Worley-Reynolds,

(Continued on Page 179)

NORTH CENTRAL TEXAS

Locations Staked for Two Deep Wildcat Tests in Jack County

By W. D. THORN

WICHITA FALLS, Tex.—Wildcat activity continued to embrace and surround Jack County last week as two new deep tests were located in the county and a third was staked on the Jack-Clay County line.

Gulf Oil Corp. staked 1 H. B. Bowen, in the SE cor. Section 2641, T.E.&L. Survey, just north of the Jack County line and in Clay County. It will be carried to depth sufficient to test the Strawn, Bend, Mississippian, and Ordovician formations. In Jack County, Hanlon-Buchanan, Inc., staked 1 Mrs. Dorcas H. Hensley A, a 6,000-ft. Ellenburger wildcat 8 miles southeast of Jacksboro, and in the B. F. Terry Survey, 6 miles southwest of Perrin, the active independent partnership firm of L. S. Youngblood of Oklahoma City and Robert L. Foree of Dallas made location for 1 C. P. Clayton, to be drilled to 5,700 ft., which should reach the Ellenburger. It is located 4,393 ft. from the north line and 1,980 ft. from the east line of the W. P. Kinkernon Survey A-325.

Mudge Oil Co. 10 Harrison, discovery producer in the Mississippian lime in the Knox pool area, was completed flowing 296 bbl. of 43-gravity oil in 6 hours through 7/16-in. choke, natural, from lime pay at 4,764-70 ft.

Hanlon-Buchanan, Inc., 1 Charles Hunter, Mississippian producer in the Burns-Ragland field east of True, Young County, flowed 270 bbl. of oil in 7 hours, natural, through open tubing, from perforations opposite the lime pay at 4,854-64 ft.

NORTH CENTRAL TEXAS COMPLETIONS

Wildcats

Archer County: Bridwell Oil Co. 1 Mrs. Emilie Buerger et al, Sec. 121, J. W. Harris subd., dry, T.D. 1,386 ft.

Burma Pet. Co. 2 Ethel O. Lemmons, Lot 3, G. P. Meade subd., dry, T.D. 1,312 ft.

Cable Oil Co. 1 Mrs. J. H. Carter, Sec. 96, A.T.N.C.L. Sur., dry, T.D. 1,620 ft.

J. M. Seaberry 1 S. Moss, Sec. 2479, T.E.&L. Sur., location abandoned.

Collins County: D. Miller 1 Y. T. Manning, William Aiken Sur., 6 mi. SW Leonard, dry, T.D. 3,010 ft.

Wichita County: Panhandle Ref. Co. 1 Southland Life Ins. Co., J. Wheat Sur. A-549, 2 mi. NE Burkburnett, dry, T.D. 2,006 ft.

Fields

Watson, Clay County: Roy Lee, trustee 2 G. J. Conrady, J. H. Fisher Sur. A-154, flowed 132 bbl., pay 5,398 ft., acid 3,000 gal., T.D. 5,552 ft., P.B. 5,425 ft.

Petrolia, Clay County: H. T. Merrill 1 Magnolia fee, Sec. 48, Parker C.S.L. Sur. A-374, dry, T.D. 850 ft.

Thornberry, Clay County: W. H. Metzner 1 Taylor & Riley, J. Duncan Sur. A-112, dry, T.D. 1,190 ft.

Muenster, Cooke County: F. W. Merrick, Inc., 5 J. H. Otto, Lot 5, George Ivy Sur. A-516, pumped 6 bbl., pay 1,498 ft., T.D. 1,502 ft.

Bryson, Jack County: Hill & Hill 5 J. R. Clayton, B. L. Knight Sur. A-324, pumped 20 bbl. oil plus 50 bbl. salt water, pay 4,654 ft., T.D. 5,396 ft., P.B. 4,703 ft. (new pay).

Ringgold, Montague County: Gulf Oil 1 W. B. Worsham estate, Sec. 33, H.T.&C. Sur., Blk. 4, old well deepened, old T.D. 5,701 ft., flowed 396 bbl., pay 5,801 ft., T.D. 5,811 ft.

Knox, Young County: Mudge Oil Co. 10 W. B. Harrison, Sec. 3407, T.E.&L. Sur., flowed 1,180 bbl., pay 4,764 ft., T.D. 4,770 ft. (new pay).

WEST CENTRAL TEXAS COMPLETIONS

Wildcats

Callahan County: Cosden Pet. Corp. 1 A. B. Hutchinson, Sec. 303, S.P.R.R. Sur., dry, T.D. 3,404 ft.

E. M. Thomason 1 W. M. Wright, Jesse Dryson Sur. 751, location abandoned.

Shackelford County: B. & F. Bonded Cotton Warehouse 1 W. H. Green, Sec. 70, Blk. 11, T.&P. Sur., dry, T.D. 1,005 ft.

Taylor County: Drilling & Exploration Co., Inc., et al 1 D. J. Gibson, Lot 8, Grimes C.S.L. Sur. 147, dry, T.D. 3,100 ft.

Fields

Crownover, Brown County: Guyle Greynolds' 1 Ella Newton, John Carr Sur., dry, T.D. 1,223 ft.

South Noodle Creek, Jones County: Humble Oil 1 W. L. Gunter, Sec. 34, Blk. 18, T.&P. Sur., flowed 38 bbl. oil and 22 bbl. water, pay 3,068 ft., T.D. 3,081 ft., P.B. 3,080 ft.

Nail, Shackelford County: R. H. Roark et al 3 J. H. Nail Est., Sec. 136, E.T.R.R. Co. Sur., pumped 28 bbl. pay 1,549 ft., T.D. 1,558 ft.

View, Taylor County: Tal-Vez Oil Co. 1 C. Braune, Lot 13, Guadalupe C.S.L. Sur. 120, dry, T.D. 2,507 ft.

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Extensive Lease Play Indicated For Colorado's Denver Basin

By T. R. INGRAM

DENVER, Colo.—Indications of a big lease play by the major oil companies in the Denver basin, northeastern Colorado, next spring continue to multiply almost daily. The current activity is due to the General Petroleum Corp. discovery at Horse Creek, on the northwest rim of the basin, in southeastern Wyoming. Reports of seismograph crews being in the field are widely circulated, but a careful check shows that such rumors are premature. Representatives of a number of majors are now or have been in this area, including Amerada, Pure, Shell, Gulf and Magnolia companies, but these have confined their activities mostly to reconnaissance surveys with a view to determining whether they will become participants. It is quite evident, however, that some of these will undertake seismograph work in the spring. Surface indications of structure in the area are comparatively limited on account of the blanket of Tertiary beds which cover most of the territory and it is generally conceded that geophysical methods must be used to locate stratigraphic traps and folding under the Tertiary. Some of the companies mentioned gathered extensive information on the area in the past which will facilitate any renewal of their activity. One at least went so far about 5 years ago as to block up several structures and put on record a number of leases. The structures then considered are along the western rim of the basin in the relative position of Horse Creek. In the meantime there is extensive leasing already under way by speculative interests.

The Pure Oil Co. has made a location for its 1 R. E. Cox, SW SW SE 16-5n-8ecm, Cimarron County, Oklahoma, 6 miles south of the Baca County line in Southeast Colorado. It will be an Ordovician test to 7,500 ft. Noble Drilling Co. has the contract and is building rig. Location is 2 miles northeast of Keyes, Okla., and 30 miles east of Boise City.

Location for Hunt Oil Co. 1 Turner-McMillen, C SE SE 5-26s-16e, Otero County, given in this column last week, was inadvertently placed in Colorado, where it should have been in a county of the same name in New Mexico.

Trigood Oil Co., which is becoming active in the Rocky Mountain area, made another location this week in the Notches field, Natrona County, Wyoming, where it is drilling one well, and another in its 1 Wilson, NW NE NW 28-54n-100w, McCollough Peak district, Park County, bringing the present number of active operations to seven, including four in Cut Bank. The company is controlled by Julius M. Goodstein and associates.

Continental Oil Co. 1 Coltharpe, C SE NW 18-51n-66w, Moorcroft district, northeastern Wyoming, has stopped at 1,512 ft. to condition hole and make a drill-stem test of a show of oil in 20 ft. of sand above that depth.

COLORADO COMPLETIONS

Rangely field, Rio Blanco County: Desert Oil Co. 1 Rector, Lot 6, 35-2n-102w, T.D. 1,300 ft., abandoned.

WYOMING COMPLETIONS

Kirby Creek, Hot Springs County: John B. Honburg, 1 State, SW SW SW 16-43n-92w, T.D. 414 ft., Frontier 411-14 ft., dry.

La Barge, Sublette County: Texas Co. 1-FX Government, SW SW NW 34-27n-113w, T.D. 1,419 ft., pumped 27 bbl. per day.

Pilot Butte, Fremont County: British American Oil Producing Co. 1 Suzanne Enos, CEL NW NW 22-3n-1w, T.D. 6,396 ft., 7-in. 6,305 ft., top Tensleep 6,302 ft., 480 bbl. on the pump.

Poison Spider, Natron County: Investors Oil Co. 5 Government, SW NW NE 3-33n-83w, T.D. 2,582 ft., pumped 31 bbl. from the Tensleep.

MONTANA COMPLETIONS

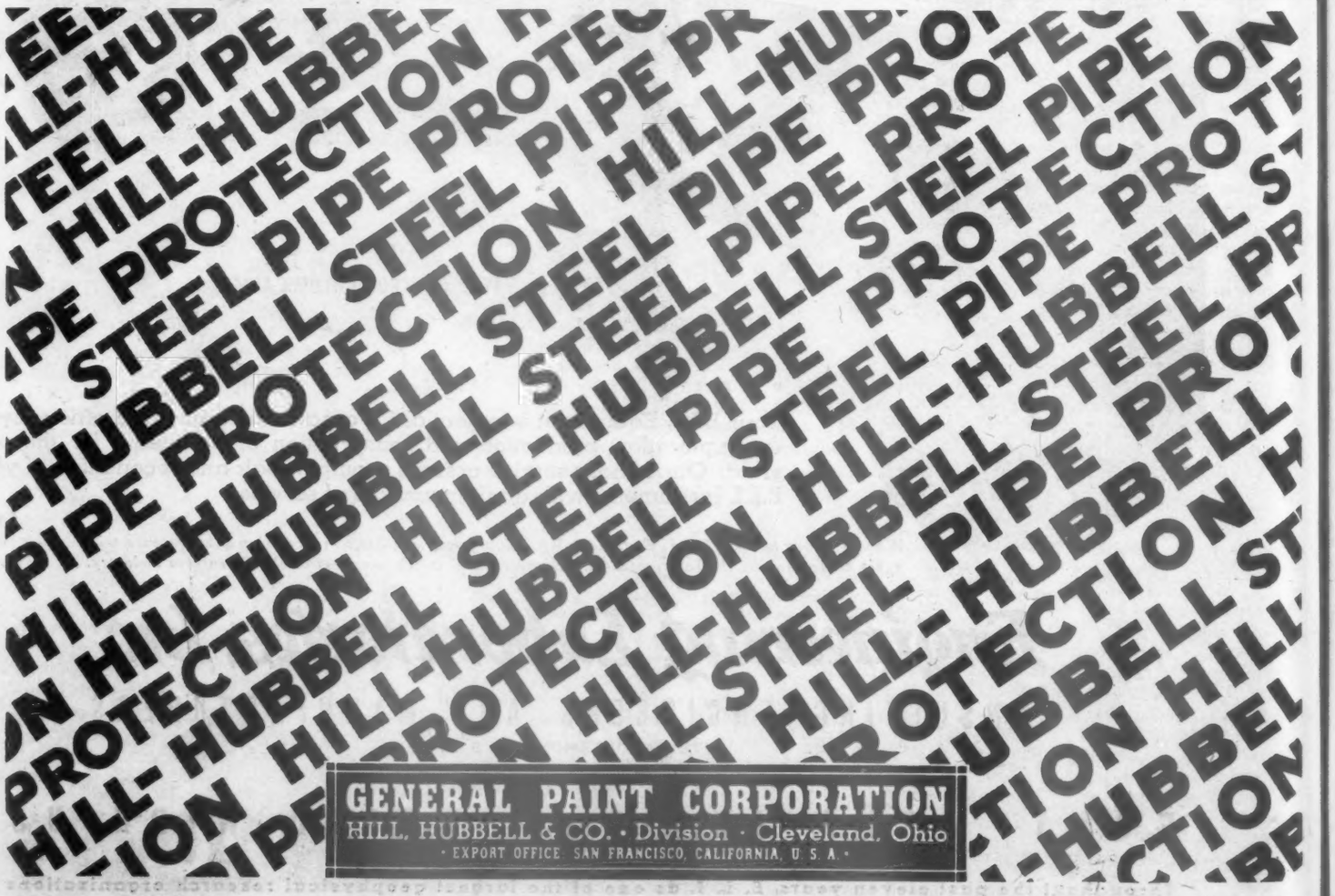
Kevin-Sunburst, Toole County: Enfield Oil Co. 8 Zachor, SE NW 20-35n-1w, T.D. 1,560 ft., P.B. to 1,556 ft., acid. 500 gal., averaged 25 bbl. in 10-day test from contact at 1,543-55 ft.

Cut Bank, Glacier County: Consolidated Gas Co. 3 Frary-Tribal-208, SE NW SE 24-32n-6w, T.D. 3,072 ft., 7-in. 3,052 ft., Sunburst sand 2,995-3,045 ft., show of oil 3,025-40 ft., Cut Bank 3,045-68 ft., main pay 3,056-68 ft., swabbed 285 bbl.

A. P. Consolidated 7 Kiesel, NW 11-34n-6w, T.D. 2,892 ft., 7-in. 2,845 ft., Cut Bank 2,831-84 ft., main pay 2,870-84 ft., swabbed 84 bbl.

Ramsey Petroleum Corp. wildcat in 14-7n-59w, Buckingham district, Weld County, Colorado, is rigging up and is due to spud next week. This is the first test in 8 years in Weld County. With good luck it may be completed this year as fast time can be made in the shales overlying the objective Dakota sands. The second well to be drilled by this company will be on what is

(Continued on Page 176)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OKLAHOMA FIELD REPORT

Creek County Wildcat Opens Gas Field From Prue Sand

By CARL HOOT

COMPLETIONS in Oklahoma were up last week with 12 oil, 4 gas, and 7 dry holes reported. Hubbell & Webb 1 Gibson, a wildcat in NE NW NW 31-14n-7e, found gas in Prue sand at 2,856 ft., set 5-in. casing at 2,854 ft. and gaged 9,500,000 cu. ft. of gas at a rock pressure of 965 lb. The well is in the southwest corner of Creek County and about 5 miles south of the Stroud pool. Gas pay had previously been found to the north of the well.

A large gas well was added to the Cement pool of Caddo County, the first completion for that field since March. Phillips Petroleum 5 Fletcher, E½ NW NW 34-6n-10w, flowed at the rate of 95,000,000 cu. ft. of gas a day through perforations at 5,040-5,140 ft. The well blew in after swabbing down to 3,000 ft. and flowed mud and water for 45 minutes before being shut in. Shut-in pressure was 1,260 lb.

Liberty Pool Plug-Back Successful

A northeast offset to the Wilcox discovery well in the Liberty pool of Noble County, Sunray Oil Co. 1 Schultz, NW SE 9-22n-2e, flowed 340 bbl. of oil a day through choke after plugging back to the Avant sand when water was found in the second Wilcox at 4,523 ft. Drilled to total depth of 4,543 ft., a drill-stem test at 4,521-32 ft., recovered 270 ft. of mud with no shows. It was then plugged back to 3,100 ft. and casing ripped at 3,020-23 ft. which recovered a slight show of oil with 4 bbl. of water an hour. A second plug-back was to the Avant sand where casing was ripped and a shot placed at 2,600-08 ft. After cleaning out, the well started flowing and was gaged through ¾-in. choke, making 165 bbl. of water along with the oil. The successful completion of this well, together with the prolific Wilcox strike a mile northeast of the field at Deep Rock 1 Dailey, should stimulate the field, which received so many setbacks when a number of wells immediately surrounding the discovery well found water at its producing level.

North Okemah Active

Three completions were reported in the old North Okemah area of Okfusgee County, one of which was a good producer. British American 1-B Bloss, SW NE SW 36-12n-9e, flowed 220 bbl. of oil a day from Gilcrease sand at 3,112 ft. The same company's 1-A Martin in Section 35 pumped 20 bbl. a day from Gilcrease at the same level.

The East Watchorn pool of Pawnee County has been expanding rapidly and last week was extended ½ mile south by J. E. Crosbie 1 Doyle, SW NW NW 36-23n-3e, which made initial potential of 432 bbl. of oil a day. Drilled to 3,912 ft. in Wilcox sand, 2-in. tubing was set at 3,910 ft. and the fell flowed 18 bbl. of oil an hour through ⅛-in. choke, with no water, after perforating at 3,860 ft.

The Apache pool of Caddo County continued its trend northwest with the completion of Amerada 3 Hunter, SW NW SE 34-6n-12w, which flowed 515 bbl. of oil a day in pay at 3,883-3,978 ft. The northwest tip of the pool is now within ½ mile of the Texas Co. 1 Starr which found the sand low at 4,128 ft. and was dry at total depth of 4,376 ft.

OKLAHOMA COMPLETIONS

Wildcats

Payne County: Lewis Producing 1 Nessling, NE SE 24-18n-1w, dry, T.D. 5,398 ft., Layton 3,950 ft., Bartlesville 4,857 ft., Viola 5,226 ft., Wilcox 5,293 ft., second Wilcox 5,360 ft.

Creek County: Hubbell & Webb 1 Gibson, NE NW NW 31-14n-7e, 9,500,000 cu. ft. gas, Prue sand 2,856 ft., T.D. 2,879 ft.

Tibbens 1 McMillan, NW SW 1-15n-9e, dry, T.D. 2,939 ft., Bartlesville 2,520 ft., show oil 2,923 ft.

Seminole County, 3 mi. NW of Cromwell: Richard Hughes 1 Foster, SE NW NW 19-11n-8e, dry, T.D. 3,685 ft., Earlsboro 3,070 ft., Bartlesville 3,160 ft., Cromwell 3,666 ft.

Fields

Apache, Caddo County: Amerada 3 Hunter, SW NW SE 34-6n-12w, flowed 515 bbl., Simpson 3,883-3,978 ft., T.D. 3,990 ft.

Cement, Caddo County: Phillips 5 Fletcher, E½ NW NW 34-6n-10w, 95,000,000 cu. ft. gas at 5,040-5,140 ft., T.D. 6,546 ft.

Hewitt, West, Carter County: Dixon-Lausen 10 Woodworth, SW NE NW 20-4s-2w, pumped 30 bbl., sand 2,165-2,200 ft., T.D. 2,385 ft.

Batson-Sanders 3-A Williams, NE NW SE 20-4s-2w, pumped 111 bbl., sand 2,532-43 ft., T.D. 3,079 ft.

Liberty, Noble County: Sunray 1 Schultz, NW SE 9-22n-2e, flowed 340 bbl. through choke, Avant sand 2,600-08 ft., T.D. 4,543 ft.

Lucien, Northeast, Noble County: Danciger 1 Donahey, NW SE NW 4-20n-2w, dry, T.D. 5,402 ft., Wilcox 5,310 ft., second Wilcox 5,386 ft.

Lovell, Logan County: Bohan Bros. 1 Sache, NE SW 28-18n-4w, 10,000,000 cu. ft. gas, Hoover sand

(Continued on Page 178)

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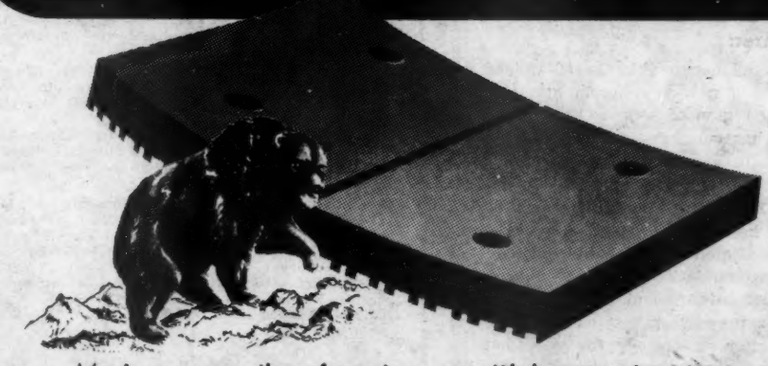

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CALIFORNIA FIELD REPORT

Central California Gas Pools May Go On Full Production

By L. P. STOCKMAN

LOS ANGELES, Calif. — With the advent of cooler weather, many of California's commercial dry gas fields will go on production within the next 2 weeks and this production will be increased by withdrawals of injected gas from the Goleta gas field in Santa Barbara County and possibly small withdrawals from the Playa Dey Rey field of Los Angeles Basin later in the year or early in 1943. It all depends upon whether a cold winter is experienced resulting in peak demand for natural gas for heating and other domestic uses. The past several winters have been mild but in spite of this domestic demand has been high due to abnormal growth of the general area incident to defense work. Under normal conditions there would be enough natural gas to serve all domestic purposes but the entrance into California of people from eastern areas has greatly increased the normal load. Rio Vista gas field has been on production to a limited extent for several months and will probably go on full production shortly. Natural gas produced in conjunction with crude oil has a priority but when this output drops below demand the natural gas fields that do not produce any crude oil are called upon to meet the deficiency. Certain changes in outlets has restricted production in San Joaquin Valley fields and hence several of the gas fields in the central part of the state may go on full production for the first time since discovery. That this would become a possibility has been recognized for several months and preparations have therefore been made to cut in additional fields as needed.

Suisun Bay Area

It was expected before this that Standard Oil Co. would have a new commercial gas field in the Suisun Bay region of Solano County, but the initial wildcat has run into so much unexpected trouble that it may be another several months before this field becomes a reality. The wildcat in question is 2-1 Suisun Community in 25-3n-1w. Bottom of the hole is at 7,300 ft. and, while formation tests indicated the probable existence of a substantial accumulation, water trouble developed at the last minute and this must be corrected before a production test can be finished. This wildcat, after picking up the gas sand, almost got away several months ago when gas began erupting through the marshy ground surrounding the well, but the company successfully corrected this condition after several weeks' work. Now with water entering the hole, a further delay will be experienced until corrected. In the meantime, Standard Oil Co. is building road to a second wildcat to be drilled in this area in 23-3n-1w, northwest of the original wildcat. Ohio Oil Co. probably has the makings of a commercial gas well in the Willows district of Glenn County as 1 Willows Block A in 18-20n-2w flowed at a daily rate of 3,000,000 cu. ft. of gas on a formation test at 3,204-40 ft. After the hole is cleaned out, the company will land a string of casing at 3,220 ft. Texas Co. is having considerable trouble with 1-A Walbridge in the Tuscan Springs district of Tehama County due to a high head salt water. This well is down 1,498 ft. and is the second well to be drilled at Tuscan Springs as the first well which has been abandoned at 498 ft. when it was found impossible to shut off salt water. At Rio Vista, Peter Cook has spudded in a second well on property which recently yielded him a good gas well and Standard Oil Co. has location for 1 Jordan unit in 29-3n-3e.

SAN JOAQUIN VALLEY COMPLETIONS

Antelope Plains, Kern County: Shell Oil Co. 44-6 Williams, 6-28s-20e, flowed 267 bbl., 16.1-gravity, 2.8 per cent cut, 28/64-in. bean, pressures 50/120 lb., T.D. 2,330 ft., perf. 100 mesh 2,182-2,325 ft., completed in Williams zone of Miocene age.

Belridge, South, Kern County: Belridge Oil Co. 57-33 fee, 33-28s-21e, pumped 80 bbl., 16-gravity, 7 per cent cut, T.D. 785 ft., perf. 49-785 ft., completed in upper Belridge zone of Pleistocene age.

Belridge Oil Co. 57-33-A fee, 33-28s-21e, pumped 72 bbl., 15.6-gravity, 6 per cent cut, T.D. 785 ft., perf. 472-785 ft., completed in upper Belridge zone of Pleistocene age.

General Petroleum Corp. 11-A fee, 3-29s-21e, pumped 71 bbl., 13.6-gravity, 16 per cent cut, T.D. 988 ft., perf. 716-988 ft., completed in upper Belridge zone of Pleistocene age.

Ohio Oil Co. 8 Emily Hopkins fee, 4-29s-21e, pumped 69 bbl., 16-gravity, 6 per cent cut, T.D. 850 ft., 120-mesh perf. 619-848 ft., completed in upper Belridge zone of Pleistocene age.

Coalinga, East, Fresno County: Shell Oil Co. 161-32 fee, 32-19s-15e, pumped 245 bbl., 17.4-gravity, 14 per cent cut, T.D. 2,677 ft., perf. 2,550-2,677 ft., completed in upper zone of Pliocene age.

Shell Oil Co. 117-29 fee, 29-19s-15e, pumped 320 bbl., 18.8-gravity, 3 per cent cut, T.D. 2,523 ft., perf. 2,391-3,444 ft., 2,464-2,521 ft., completed in upper Coalinga zone of Pliocene age.

Kern River Front, Kern County: General Petroleum Corp. 3 Young, 14-28s-27e, pumped 75 bbl., 14.1-gravity, 15 per cent cut, T.D. 2,078 ft., 100-mesh perf. 1,865-2,077 ft., completed in Tegeler zone of Pliocene age.

Midway-Sunset, Kern County: Standard Oil Co. 100-35-B fee, 35-31s-23e, pumped 79 bbl., 26-gravity, 10 per cent cut, T.D. 3,205 ft., perf. 2,641-80 ft., 2,721-70 ft., 2,890-2,928 ft., 3,045-83 ft., 3,270-3,308 ft., scales 2,730 ft., completed in Wilhelm zone of Pliocene age.

Mount Poso wildcat district, Kern County: Ring Oil Co. 29-2 Glide, 19-26s-28e, abandoned in barren Vedder sand of Miocene age, 1,903 ft., no showings logged.

Union Oil Co. 34 Sarrett & Mack, 4-27s-28e, pumped 195 bbl., 15-gravity, 5 per cent cut, T.D. 1,943 ft., perf. 1,866-1,943 ft., completed in Vedder zone of Miocene age.

Round Mountain, Kern County: Honolulu Oil Corp. 11-18 Round Mountain, 18-28s-29e, pumped 60 bbl. net, 15.7-gravity, 48 per cent cut, T.D. 2,113 ft., perf. 2,068-2,113 ft., completed in Vedder zone of Miocene age.

Shell Oil Co. 1-16 Jewett, 21-28s-29e, abandoned in barren Vedder sand of Miocene age, N point 1,827 ft., top Vedder zone 1,966 ft., T.D. 2,100 ft., no showings logged.

Buena Park and Turnbull Canyon Wells Nearing Testing Stage

Texas Co. should be ready to make a production test of 4-1-F Buena Park in the Buena Park field of Orange County within another 2 weeks and Continental Oil Co. should be ready for a production test on its fourth well in the Turnbull Canyon field of Los Angeles County along about the same time. Both of these fields have failed to show large production but subsequent drilling may change the picture, as based on drilling operations to date. Turnbull Canyon was discovered late last year by Continental Oil Co. and while original expectations were predicated on the existence of a large field later drilling reduced the potentially productive acreage by about 50 per cent. This reduction was accomplished when Continental's second well located in the southwestern part of the field drilled through a fault and wound up almost where it started due to a downward displacement south of the fault. This hole was then whipstocked to the north and was later finished as an excellent flowing well. The discovery well proved to be a small pumper which held up for several months but then declined and was deepened with somewhat better results. The third well drilled by Continental was located along the north flank of the structure and while no evidence of faulting was logged it failed to find production on a straight hole and was later whipstocked southward and completed as a relatively small well. Texas Co. discovered the Buena Park field early in 1942 and out of three wells drilled to date the company has two small producers. The best well finished in this field was the lowest structurally and incidentally the highest well structurally proved to be a dud. The structure at this point is a westerly plunging nose and the greatest thickness of oil sand is down the plunge. The present well now drilling is located slightly north of a straight line between the two producing wells in the field. The outlook is for a small well, but there is always a chance that a location or two may change the amount of oil sand. The productive horizon at Buena Park is believed to be the equivalent of the Bell zone of Pliocene age at Santa Fe Springs, but unlike the Bell zone, which registered substantial production, the Buena Park zone is quite thin and tighter. Texas tied up all of the potentially productive acreage at Buena Park before starting work and consequently it should be the only operator to develop production. It remains to be seen, however, whether the accumulation at Buena Park will prove commercial or fall below the amount necessary to justify additional drilling. Results of drilling to date have been somewhat discouraging and the well now drilling may determine future drilling for the time being. Continental Oil Co. has a situation somewhat similar to Texas' condition at Buena Park because the former, having drilled two small wells in the Shafter region of Kern County, is now in the position of either continuing development work or pulling out of the area. It is the present intention to sit tight and produce the wells as long as they continue to flow and then abandon the properties. Continental has only produced a small amount of crude oil from these two wells and the present outlook is that this exploratory work will be a dead loss and cannot be recovered from production. There was too much to overlook and not enough oil in the accumulation to justify further work.

LOS ANGELES BASIN COMPLETIONS

Huntington Beach, Orange County: Signal Oil & Gas Co. 44 Bolsa, 33-5s-11w, pumped 150 bbl., 25.4-gravity, 0.5 per cent cut, T.D. 4,011 ft., P.B. 3,855 ft., perf. 3,651-3,855 ft., completed in second Bolsa zone of Pliocene age.

Montebello, Los Angeles County: Standard Oil Co. 93 Baldwin, 1-2s-21w, pumped 90 bbl., 17.1-gravity, 35 per cent cut, T.D. 2,900 ft., perf. 2,463-2,899 ft., completed in first La Merced zone of Pliocene age.

Yorba Linda, Orange County: Shell Oil Co. 3-78-16 Olinda fee, 16-3s-9w, flowed 208 bbl., 15.8-gravity, 3 per cent cut, 13,000 cu. ft. gas, 58/64-in. bean, pressures 215/400 lb., T.D. 2,218 ft., P.B. 2,150 ft., perf. 1,720-1,860 ft., 1,920-2,150 ft., started pumping, then started flowing, completed in Yorba Linda zone of Miocene age.

Silty Oil Sand Cored in Aliso Canyon Deep Test

Tide Water Associated Oil Co. is coring ahead in 1 Sesnon, a deep test in the Aliso Canyon field of Los Angeles County, and the outlook is very promising as a silty oil sand has been cored below 9,000 ft. This well failed to show commercial production in the upper zones as it was brought in as a gas well and accordingly showed very little crude oil. The sand being cored in the Ses-

(Continued on Next Page)

MICHIGAN OPERATIONS

Michigan Crude Oil Production Continues Steady Decline

By OTTO C. PRESSPRICH

SAGINAW, Mich.—Falling short of its federal quota, Michigan oil production in October was at the rate of 61,880 bbl. a day for a month's production of 1,918,280 bbl., according to the compilation of yield by fields by the Oil and Gas Association of Michigan. October being a 31-day month, the output was 25,000 bbl. greater than for the previous month but the October daily average was 2,222 bbl. less as all but two of the major fields continued their slow, steady decline.

Biggest decline, around 500 bbl. per day, was noted in the leading Reed City pool which accounts for about 40 per cent of current production, its October average being 27,096 bbl. Second place Headquarters-Roscommon field was up 104 bbl. a day at 7,603 and Porter-Yost-Midland increased 100 bbl. to 3,236 bbl.

Completions last week were the lowest of the year with only six being reported. And four of them were dry holes. Small new producers in Bay County's Monitor-Kawkawlin section were developed by Gulf Refining Co. Wildcat tests in Kent, Calhoun and Montcalm counties were dry.

The state Conservation Department announced it had issued six more drilling permits bringing the 1942 total to 505. Two of the new locations are in Ottawa County, the others in Bay, Clare, Jackson and Van Buren.

MICHIGAN COMPLETIONS

Bay County, Kawkawlin Township: Gulf Refining Co. 1 Graham, C S½ SE NW 34-15n-4e, pumping 30 bbl., acidized, T.D. 2,930 ft.

Monitor Township: Gulf Refining Co. 1 Francis, C N½ NW SW 1-14n-4e, pumping 45 bbl., acidized, T.D. 2,863 ft.

Calhoun County, Marengo Township: Ashby Drilling Co. 1 Hubbard, SE SE NW 7-2s-5w, wildcat test, dry, T.D. 2,302 ft.

Clare County, Redding Township: Taggart Brothers Co. 8 Goodrich-Crane, C NW 5-19n-6w, dry hole, T.D. 1,350 ft.

Kent County, Courtland Township: Charles W. Teater 1 Hessler, C N½ NE NE 14-9n-10w, wildcat test, dry, T.D. 3,073 ft.

Montcalm County, Pine Township: American Production Co. 1 Farnsworth, SE NW SE 10-11n-8w, wildcat test, dry, T.D. 1,218 ft.

California Fields

(Continued from Preceding Page)

non well is believed to be below the deep Porter zone, which Tide Water Associated Oil Co. discovered in this field last year. This field is very rough and the topography varies from one location to another to such an extent that offsets sometimes cannot be drilled and it will require directionally drilled wells to develop the acreage on a drainage basis. The excellent condition of the oil zones, however, more than make up for this condition as Aliso Canyon is one of the better fields in the Newhall-Castaic region along with Newhall Potrero. Union Oil Co. and Standard Oil Co. each drilled a dry hole along the north flank of the Aliso Canyon field, but neither developed production. In the Del Valle field, R. E. Havenstrite is still drilling ahead in 2 Barnes, which has become a deep test, and while no additional oil sand has been found below 9,100 ft., the operator is definitely assured of commercial production higher up in the hole but below the third Modelo zone of Miocene age. The deep zone found by Havenstrite in 2 Barnes has greatly stimulated interest in this region of the state as it may indicate the probable existence of this same zone in other fields in the area.

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ILLINOIS FIELD REPORT

New Devonian Field Opened Southeast of Bartelso

MATTOON, Ill.—Outstanding among many important developments in Illinois during the past week was the discovery of a new Devonian field in Clinton County about 2 miles southeast of the town of Bartelso. The discovery well of the new field, J. F. Ashoff 1 Huelsman, SE NE NE 20-1n-3w, was formerly a dry hole but was reopened and deepened to the Devonian. When plug was drilled to that formation, the well had a showing of an undetermined amount of oil. After acidization, the test was reported swabbing at the rate of 8 bbl. of oil an hour.

The 1 Huelsman is the second Devonian discovery in Clinton County within a period of a few weeks, the first being the discovery of Devonian production in the Boulder field. In addition, two more Devonian tests have been started in the county. These are the Texas 4 C. Murphy, NE 2-2n-2w, in the Boulder pool, where surface pipe has been set, and the Gulf 1 E. Martin, SW SE SE 33-3n-1w, a wildcat about 4 miles east of the Boulder pool, drilling below 1,611 ft.

New Clay County Benoist Pool Opened

In the eastern part of the Illinois basin, leading oil developments were the prospective extension of the new Levias pool on the Jasper-Richland County line and the opening of a new Benoist pool in Clay County.

A large play is promised for the new Clay County field, opened by the Luttrell et al 1 Reed heirs, SE NW NE 15-5n-5e, about 10 miles west of the Bible Grove field, which initialed 120 bbl. of oil per day on pump. Already under way are the 2 Reed and the Texas Co. 1 Kidwell, and drilling permits have been issued for two more wells in the area.

In Richland County, just below the Jasper County line, the Sun Oil Co. is testing promising Levias pay at 2,948-54 ft. at its 1 O. Miller, SE NW NE 26-5n-10e. Gulf's 1 Otto Hulse in the same field has swabbed 30 bbl. of oil from the Levias, but its 2 Hulse missed in this formation and was to get an electrical survey.

ILLINOIS COMPLETIONS

Wildcats

Clinton County: W. B. Lagers 1 Rudolph, SE NW NW 32-3n-3w, dry at 1,054 ft., Cypress 910 ft., Benoist 1,045 ft.

Cumberland County: Milo Ritchie 1 Greeson, NE SE SW 4-10n-9e, dry at 2,491 ft.

Hamilton County: Magnolia 1 Irvin, NW NW SE 35-6s-6e, dry at 3,163 ft., Aux Vases 3,142 ft.

Texas 1 Irvin, NW SW NE 35-6s-6e, dry at 1,682 ft.

Jackson County: F. R. Wiley 1 First National Bank, SW SE SW 7-9s-3w, dry at 775 ft.

Jefferson County: Magnolia 1 Roach, NW NW NE 27-2s-1e, dry at 2,326 ft., McClosky 2,260 ft.

Macoupin County: A. M. Scroggins 1 Bates, NE SW SW 18-10n-7w, dry at 570 ft.

Perry County: C. H. Harrison 1 Brueggman, NE NE NE 11-5s-4w, dry at 1,577 ft., McClosky 1,543 ft.

Randolph County: F. Erb 1 Young, SE NE SE 2-4s-5w, dry at 685 ft.

Wabash County: Joe Bander et al 1 Siebert, NE NW SW 9-1n-13w, dry at 2,540 ft., Benoist 2,528 ft.

Wayne County: H. H. Weinert 1 Thompson, N½ SW SE 32-2s-6e, pumped 40 bbl., 1,500 gal. acid, McClosky 3,373-78 ft., T.D. 3,378 ft.

Carl Robinson 1 Riggs, S½ SE SE 33-1s-9e, dry at 3,408 ft., Weller 2,949 ft., Aux Vases 3,239 ft., McClosky 3,360 ft.

Fields

Benton, Franklin County: H. H. Wegner 4 Chicago Co., NW SE SE 26-6s-2e, pumped 142 bbl., 30-qt shot 2,154-68 ft., sand 2,150 ft., T.D. 2,168 ft.

Bible Grove, Clay County: Kingwood 1 Lewis, NW NW SW 9-5n-7e, pumped 155 bbl., natural, sand 2,534-38 ft., T.D. 2,542 ft.

W. D. Duncan 1 Behrens, NW NW NE 9-5n-7e, pumped 204 bbl., natural, Weller 2,501 ft., T.D. 2,551 ft.

Birds, Crawford County: C. L. Farnsworth 2 Barnes, NW NE SW 7-5n-11w, pumped 10 bbl., sand 953-83 ft., T.D. 983 ft.

Coil, Wayne County: W. C. McBride 1 Byars, SE NE SW 19-1s-5e, dry at 3,068 ft., McClosky 2,956 ft.

Covington, Wayne County: Kewanee 1 Beck, SW NW 29-1s-7e, pumped 264 bbl., Fredonia 3,235 ft., 1,500 gal. acid, McClosky 3,255-61 ft., T.D. 3,280 ft.

Dale, Hamilton County: Shell 4 Morris, SE NW SE 18-6s-7e, pumped 18 bbl., 20-qt. shot, Aux Vases 3,027-36 ft., T.D. 3,059 ft.

Shell 4 Summers, SE NE NE 18-6s-7e, flowed 211 bbl., 30-qt. shot 3,039-59 ft., Aux Vases 3,010-36 ft., T.D. 3,077 ft.

Texas 7-B Hall, SE NE SE 18-6s-7e, pumped 72 bbl., 50-qt. shot, Aux Vases 3,024-38 ft., T.D. 3,048 ft.

East Inman, Gallatin County: Cherry & Kidd 6 Kerwin, SE SE SW 11-8s-10e, pumped 100 bbl., Waltersburg sand 1,940-62 ft., T.D. 2,054 ft.

Friend Grove, Wabash County: Magnolia 1 Sturman, NE NE NE 10-1s-13w, pumped 85 bbl., 30-qt. shot 2,320-28 ft., Weller 2,315-28 ft., T.D. 2,686 ft.

Skiles 2 Smalley, SE SE NE 3-1s-13w, pumped 176 bbl., Cypress 2,313 ft., T.D. 2,325 ft.

Johnsonville, Wayne County: Mid-Continent 1 Spitzmer, NW NE NW 4-1s-8e, dry at 3,224 ft., Ste. Genevieve 3,141 ft.

Louden, Fayette County: Carter 1 Lilley, SE SE NW 16-8n-3e, pumped 28 bbl., Weller 1,517 ft., T.D. 1,600 ft.

Mason, Effingham County: Tide Water 5 Burk, NE SE SW 27-6n-5e, pumped 105 bbl., Aux Vases 2,358-74 ft., 50-qt. shot 2,362-74 ft., T.D. 2,374 ft.

Kingwood 1 See Est., NW SW SE 27-6n-5e, pumped 36 bbl., in 8 hr., 5-qt. shot 2,296-2,300 ft., Aux Vases 2,357-75 ft., T.D. 2,387 ft.

Kingwood 2 See Est., SW SW SE 27-6n-5e, pumped 68 bbl., 15-qt. shot, Aux Vases 2,358-71 ft., T.D. 2,376 ft.

Mount Erie, Wayne County: Pure 1-A Fishel, W½ SW NW 35-1n-8e, pumped 54 bbl., 60-qt. shot, Aux Vases sand 2,980-98 ft., T.D. 3,215 ft.

Mount Carmel, Wabash County: Kennedy et al 6 Carson, SW SW SW 16-1s-12w, pumped 200 bbl., 1,000 gal. acid, reacidized 2,000 gal., McClosky 2,304-12 ft., T.D. 2,312 ft.

New Harmony, White County: Herndon Drlg. 1-1 Bond, SW NW NE 8-4s-14w, gas input well, T.D. 2,837 ft.

Ivan White 3 Lomas, NE NW SW 14-4s-14w, pumped 120 bbl., 40-qt. shot 2,230-41 ft., Tar Springs sand 2,209 ft., T.D. 2,241 ft.

Cal Star Pet. 16-B Miller-Ford, NE SE NW 21-4s-14w, flowed 425 bbl., 60-qt. shot 2,689-2,702 ft., Benoist 2,696-2,713 ft., T.D. 2,854 ft.

Noble, Richland County: W. W. Shaffer et al 2 Boley, S½ NE NW 33-4n-9e, dry at 2,648 ft., Weller 2,625 ft.

Phillipstown, White County: Jarvis & Marcell 6 Spencer, SE NW SW 31-4s-11e, pumped 140 bbl., natural, sand 2,323-40 ft., T.D. 2,340 ft.

Jarvis & Marcell 5 Spencer, NW SE SW 31-4s-11e, pumped 400 bbl., 30-qt. shot 2,336-51 ft., sand 2,327-51 ft., T.D. 2,351 ft.

Sun Oil 3 Hoosier-Spencer, NW NE NW 6-5s-11e, pumped 33 bbl., 30-qt. shot, sand 2,324-53 ft., T.D. 2,353 ft.

Roland, White County: Sinclair 2 Rainey, NW NE SE 2-7s-8e, pumped 102 bbl., Benoist 2,778 ft., T.D. 2,970 ft.

Rural Hill, Hamilton County: Texas 4-A Hall, W½ NE NW 18-6s-6e, flowed 911 bbl., Aux Vases 3,103-16 ft., 3,118-23 ft., 50-qt. shot 3,100-25 ft., T.D. 3,125 ft.

Texas 1 Gott, NW SE NW 18-6s-6e, pumped 55 bbl., 12-qt. shot, Aux Vases 3,187 ft., T.D. 3,209 ft.

Shell 2 Hungate, SW NW SW 24-6s-5e, flowed 475 bbl., 25-qt. shot 3,105-22 ft., Aux Vases 3,091-3,127 ft., T.D. 3,131 ft.

Magnolia 3 Hamilton, E½ NE SW 24-6s-5e, flowed 250 bbl., Aux Vases 3,107-24 ft., 3,127-54 ft., T.D. 3,308 ft.

St. Jacob, Madison County: E. A. Obering 1 Schoeck, SW SE SE 27-3n-6w, pumped 85 bbl., Trenton 2,315 ft., T.D. 2,341 ft.

Sims, Wayne County: Texas 3 Harlan, NW NW SE 22-1s-6e, pumped 22 bbl., Aux Vases 3,072-92 ft., T.D. 3,209 ft.

Stokes, White County: Pure 1-B Pyle, NW SW SW 17-6s-4e, pumped 45 bbl., Benoist sand 2,778-87 ft., 45-qt. shot, T.D. 2,800 ft.

South Lawrence, Lawrence County: Smith & Nye 2 Vanwey, NE NW NE 26-2n-12w, pumped 145 bbl., natural, Biehl 1,310-23 ft., T.D. 1,327 ft.

E. O. Olds 5 Vanwey, NE SE SE 23-2n-12w, dry at 1,910 ft., Cypress 1,791 ft., Benoist 1,893 ft.

South Sailor Springs, Clay County: W. C. McBride 1 Armstrong, SE SW NW 10-3n-7e, pumped 42 bbl., Cypress 2,590 ft., pay 2,600-09 ft., T.D. 2,609 ft.

Walpole, Hamilton County: Texas 3 Bond, W½ SW NE 34-6s-6e, pumped 174 bbl., 10-qt. shot 3,103-08 ft., Aux Vases 3,093-98 ft., T.D. 3,108 ft.

Miscellaneous, Hamilton County: Magnolia 2 Travis, NE SE SE 20-4s-7e, dry at 3,527 ft., McClosky 3,483 ft.

Texas 1 H. Ledbetter, NE NE NW 21-4s-7e, dry at 3,480 ft., Ste. Genevieve 3,326 ft.

SOUTHWEST TEXAS

Cameron County Wildcat Dry With No Shows Reported

By T. F. SMILEY

CORPUS CHRISTI, Tex.—The deepest wildcat test in the Rio Grande Valley, the Standard Oil of Texas-Shell Oil Co. 1 M. Fredericks, was abandoned last week at a total depth of 9,007 ft. No shows were encountered in the well, which was in the San Benito subdivision of Cameron County and the only wildcat drilling in that county. Another lower Gulf Coast wildcat finished dry was Henshaw Brothers 1 Tanherez, in the Cubbage-Miller subdivision of the O'Connor ranch in San Patricio County. Details concerning the test were not given out, but it is understood to have gone to a total depth of 6,185 ft. without shows.

American Liberty Oil Co. has staked location for a Wilcox test in the Burnell gas area of Karnes County. The well, 1-W Otto von Roeder, is to go to 7,500 ft. It is in the J. Johnson Survey.

Prospecting of a 3,600-acre lease in Hidalgo County will begin with the drilling of a test staked by Sun Oil Co. in Section 23, Newman subdivision of El Benito grant. The well, 1 D. D. Oil Co., is east of the North Sun field in Starr County and northeast of Rincon field. It is to go to 9,000 ft.

Dirks Brothers are moving in material for a wildcat test, 2 C. S. Page estate, 1 mile south of Mineral in the Thomas K. Pilkington Survey of Bee County.

Gulf's wildcat, 2 Virginia Tatton, 3½ miles east of Tom O'Connor, in Refugio County, found no shows from 7,814 ft. to 8,002 ft. It encountered a slight gas odor at 8,010 ft. and no shows after that. It was drilling ahead at 8,425 ft.

Sun is rigged up for a wildcat test in the southern half of Jim Hogg County, 11 miles southeast of Randado in La Noria de Santo Domingo grant. This test, 6 Mrs. A. L. East, will be carried to 5,500 ft.

Ogden & Voyles 1 Richardson, in the western half of Duval County, 3 miles south of the Kohler field, shut down for storage after testing 50 bbl. on the pump, with perforations at 1,780-94 ft. The same interests have staked locations for another test, 2 Richardson, to go 2,000 ft.

Continental has staked location for a Pettus sand test in the Michael Caronican Survey in Live Oak County, 2 miles southwest of Oakville. It is the 1 Albert W. West et al.

Henderson Coquat 5-C Southland Life Insurance Co., 3 miles southwest of Sweden townsite in Duval County, was completed dry at 5,081 ft. Oil odor was encountered at 4,933-52 ft. and 5,065-71 ft.; gas odor at 4,953-63 ft.

In a 20-minute drill-stem test Humble's wildcat 1 A. C. Soechting, near Imogene, Atascosa County, showed no pressure at 7,574-81 ft. It recovered 30 ft. of oily mud through a $\frac{1}{16}$-in. bottomhole choke, with open valve on top. A similar test for 41 minutes at 7,575-83 ft. recovered 160 ft. of mud, with slight shows of oil. The crew was preparing to core ahead from 7,583 ft.

Humble completed its deep Edwards lime test, 1 M. L. Thompson, in Atascosa County, on the pump, producing 38.15 bbl. of oil and 70.85 bbl. of salt water daily. The well, a discovery, was drilled to 7,576 ft., but was plugged back to 7,572 ft. to shut off water. It is 1,820 ft. southwest of Hum-

(Continued on Page 179)

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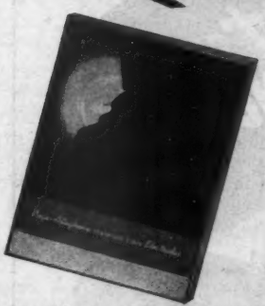

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THE OIL AND GAS JOURNAL

APPALACHIAN FIELDS

Pennsylvania Oriskany Failure To Be Deepened to Clinton

PITTSBURGH, Pa.—In Southwest Pennsylvania, an Oriskany test which failed of production is being deepened to the Clinton and another test on Chestnut Ridge in Fayette County struck water in the Oriskany sand. In West Virginia, an Oriskany test in Jackson County found water in the sand mixed with a little oil.

SOUTHWEST PENNSYLVANIA

In Slippery Rock Township, Lawrence County, the test of T. W. Phillips Gas & Oil Co. on the Delilah Hill farm which had an uncommercial showing of gas in the Oriskany sand is now being deepened to the Clinton sand and a 6-in. hole is being carried. If a heavy volume of water is found in the Newburg horizon, then the test may be terminated there. The showing of gas in the Newburg recently in Mercer County is an incentive. In the Hill test, the surface elevation is 1,197 ft., with top of Oriskany at 4,664 ft.

On Chestnut Ridge in South Union Township, Fayette County, Greensboro Gas Co. abandoned 3 Barton after striking salt water in the Oriskany sand. The surface elevation was 2,451 ft., Onondaga chert 7,631 ft., Oriskany 7,795 ft., total depth 7,810 ft., where the water was struck in volume. Its No. 2 was also a failure.

On Laurel Ridge in Ligonier Township, Westmoreland County, New Penn Development Co., William E. Snee et al were drilling at 7,035 ft. in the test on the John and Eleanor Beck farm. The hole had reached 7,128 ft. but was cemented back to straighten it and recover action of the tools and it is now drilling in a new hole. In Maryland, William E. Snee et al reached 4,600 ft. in the old 1 Speicher on the Accident dome, Garrett County, and the tools are now past the lost bailer which was cemented in.

SOUTHWEST PENNSYLVANIA COMPLETIONS

Clarion County, Porter Township: B. Burns et al 1 John Males, 116,000 cu. ft. gas, T.D. 2,750 ft.

Red Bank Township: Owens-Illinois Glass Co. 1 J. L. Blotzer, 19,000 cu. ft. gas at 2,780 ft. and 3,035 ft., T.D. 3,204 ft.

Fayette County, Nicholson Township: Wahler-Powers Oil & Gas Co. 1 Melvin Woodrich, drilled deeper, 26,000 cu. ft. gas, Big Injun 1,238 ft., gas 1,381 ft., T.D. 1,417 ft.

South Union Township: Greensboro Gas Co. 3 Barton heirs, dry, Onondaga chert 7,631 ft., Oriskany 7,795 ft., water 7,810 ft., T.D. 7,810 ft.

Greene County, Center Township: Mfgrs. Light & Heat Co. 3 George E. Grimes, 4,721-000 cu. ft. gas, Fifty-Foot sand 3,064 ft., gas 3,107-14 ft., T.D. 3,114 ft.

Jackson Township: Mfgrs. Light & Heat Co. 1 N. C. Woodruff, 191,000 cu. ft. gas, Fifty-Foot 2,805 ft., gas 2,825-28 ft., T.D. 3,332 ft.

Mfgrs. Light & Heat Co. 1 Belle Grinnage, 759,000 cu. ft. gas, Fifty-Foot sand 2,920-77 ft., gas 2,938 ft., Gordon sand 3,074 ft., gas 3,089-96 ft., T.D. 3,096 ft.

Indiana County, South Mahoning Township: Equitable Gas Co. 3279 D. W. Daraigh, 304,000 cu. ft. gas, Murraysville sand 1,127 ft., gas 1,165-77 ft., R.P. 270 lb., T.D. 1,194 ft.

Washington County, Morris Township: South Penn Oil Co. 2 R. W. Sharpnack, dry, T.D. 3,180 ft.

WEST VIRGINIA

In Oceana district, Wyoming County, Godfrey L. Cabot, Inc., was drilling below 5,672 ft. at 1047 Watts Land Co. and this deep test will be of interest. In Marsh Fork district, Raleigh County, Columbian Carbon Co. has reached 2,679 ft. at 663 Rowland Land Co. with the Big lime topped at 2,181 ft., 125,000 cu. ft. gas initial at 2,504-07 ft. and now gaging 30,000 cu. ft.

In Meade district, Tyler County, Benedum & Trees were drilling at 6,071 ft. in the test on the Pearl Broadwater farm with the Corniferous lime topped at 6,037 ft. and casing set at 6,038 ft.

WEST VIRGINIA COMPLETIONS

Calhoun County, Sheridan district: Francis E. Pettit 1 Francis Cain, 5 bbl., Salt sand, T.D. 1,760 ft., South Penn Natural Gas Co. 8 Frank E. Rothlisberger, 1 bbl., Maxton sand, T.D. 1,996 ft.

Sherman district: South Penn Natural Gas Co. 9 Henry Brannon, dry, Injun, T.D. 2,175 ft.

McCall Drilling Co. 3 T. S. Cunningham, 8 bbl., Big lime 2,130 ft., Big Injun 2,197 ft., T.D. 2,326 ft.

Clay County, Buffalo district: Pittsburgh & West Virginia Gas Co. 7889 Elk River Coal & Lumber Co., 470,000 cu. gt. gas, through Injun sand, T.D. 1,717 ft.

Pittsburgh & West Virginia Gas Co. 7894 Elk River Coal & Lumber Co., 139,000 cu. ft. gas, through Injun sand, T.D. 2,146 ft.

Gilmer County, Center district: Pittsburgh & West Virginia Gas Co. 7528 J. L. Upton, drilled deeper, dry, old T.D. 1,645 ft. in Salt sand, Blue Monday 1,847-77 ft., Big lime 1,877-1,940 ft., Injun 1,940-2,048 ft., show gas 1,960 ft. and 2,012 ft., T.D. 2,081 ft.

Glenville district: H. B. Scott 1 Eugena May Crites, 2,500,000 cu. ft. gas, Big libe 1,525 ft., Injun 1,614 ft., T.D. 1,698 ft.

Kanawha County, Cabin Creek district: Hope Natural Gas Co. 8621 John Q. Dickinson, 152,000 cu. ft. gas, Big lime 2,446 ft., will acidize.

Mingo County, Hardee district: Shewey Collier et al 1 Tom Waldron, 103,000 cu. ft. gas, Big lime 1,483 ft., T.D. 1,668 ft.

Nicholas County, Jefferson district: T. G. Ramsey 1 C. D. Backus, 340,000 cu. ft. gas, through Injun sand, T.D. 1,757 ft.

Putnam County, Curry district: R. H. Adkins 1 Harvey C. Tincher, 133,000 cu. ft. gas in Berea, Big lime 1,720 ft., Injun 1,883 ft., Berea 2,374 ft., T.D. 2,402 ft.

(Continued on Page 177)

LOUISIANA GULF COAST

Bully Camp Discovery Completed As Shallow Gas Producer

By T. F. SMILEY

NEW ORLEANS, La.—Bully Camp is the name given to the new shallow gas field opened by Gulf 1 Delta Securities Co. in 1-19s-20e, La Fourche Parish. The well, drilled to a total depth of 1,496 ft., was plugged back to 1,010 ft., where it was producing 750,000 cu. ft. of dry gas through $\frac{5}{16}$-in. and ¼-in. tubing chokes, with perforations at 996-1,002 ft.

Opening of an important gas and distillate field, with possibilities of oil, is seen as a likelihood in Union Sulphur 1 J. P. Gueno, 51-8s-2e, Acadia Parish. The well, which experienced a blowout and fire several weeks ago, is reported to be flowing 2,450 bbl. of 51-gravity distillate daily through 2-in. chokes on the christmas tree. Gas accompanies the distillate, and the crew had difficulty closing the well.

Union Oil of California made a 4-hour drill-stem test on its Vermilion Parish wildcat, 1-C Louisiana Furs, Inc., at 11,124-32 ft., with ⅛-in. chokes at top and bottom. The test showed some gas and a small quantity of distillate. The maximum pressure was 4,200 lb. As the week closed, the well was being cleaned out at 11,665 ft.

Superior Oil Co. 2 La Terre Oil Co., Inc., 28-19s-15e, Terrebonne Parish, was drilling in shale at 10,441 ft. At 10,150 ft. the well was running 40 ft. higher structurally than No. 1.

LOUISIANA GULF COAST COMPLETIONS

Wildcats

La Fourche Parish: Gulf 1 Delta Securities, 1-1s-20e.

(Continued on Page 175)

Paluxy Sand Field Indicated In Northern Wood County

By W. D. THORN

DALLAS, Tex.—Another Paluxy sand field appears definitely established in northern Wood County at Delta Drilling Co., L. B. (Rube) Benton, and Henry A. Roach 1 Goldsmith, wildcat 3 miles northwest of Quitman, and in the S. G. Purse Survey. Located on a well-known geophysical prospect which previously had been condemned for the shallower Woodbine production, this new strike is believed by some geologists likely to be about twice the size of the recently discovered Coke field some 8 miles to the northeast, which covers close to 1,200 acres.

No. 1 Goldsmith topped the Paluxy formation at 6,253 ft. Between that point and 6,310 ft. it was estimated to have encountered approximately 50 ft. of net oil sand and was coring ahead at the close of the week at 6,334 ft., with no drillstem test yet taken on the pay section. Elevation is 485 ft. It is being drilled on a block farmed out by Shell Oil Co., Inc., to Benton and Roach, who subsequently completed a deal with Joe Zeppa, head of Delta Drilling Co. of Tyler, Tex., to drill a Travis Peak test, or to 9,000 ft. However, it probably will set pipe and complete in the Paluxy instead of filling its contract depth. The independent partnership of Benton and Roach is composed of L. B. Benton of Fort Worth, geologist, operator, and broker, and Henry A. Roach, Fort Worth operator who last month was inducted into the Army and currently is on duty in Indiana.

Although this well gives promise of being the discovery of a major field, it is feared by many operators that its crude will be similar to that produced from the Paluxy sand in the Coke field, which is low in octane rating, lacking in asphaltic qualities, and which does not yet have a pipeline outlet. However, the Paluxy sand crude produced in the Talco field is especially valuable because of its asphalt content and it is quite possible that crude from this prospective new area would carry properties not contained in the Coke field crude.

Geologically, and from the over-all reserves viewpoint, the discovery is very important as it enhances considerably the probability that a number of other known prospects in the general area which previously have been found dry in the Woodbine, will prove productive when adequately tested in the deeper Paluxy zone. One such prospect is now being drilled. It is Magnolia Petroleum 1 McCreight, about 4 miles northwest of the 1 Goldsmith. Magnolia's test was drilling near the Woodbine zone.

O. W. Killam of Laredo, Tex., is moving in material for a Paluxy sand wildcat 6 miles southwest of Canton in Van Zandt County, at 1 G. A. Wages et al, in the southeast corner of a 175-acre tract.

W. L. Patrick of Houston, Tex., was reported moving in heavy rig for a 9,500-ft. Travis Peak test in the Sand Flats area of Smith County, at 1 Oliver Hatchet, on a 51-acre tract in the Samuel Leeper Survey.

EAST TEXAS COMPLETIONS

Fields

Kildare, Cass County: C. C. Gilger 2 Cass County fee, J. Wanhope Sur., flowed 626 bbl. through ¼-in. choke, perf. casing 5,990-6,022 ft., T.D. 6,055 ft. Texas Co. 1 Benefield & Singleton, J. Wanhope Sur., flowed 986 bbl. through ¼-in. choke, perf. casing 5,993-6,010 ft., T.D. 6,032 ft.

Marion Shallow, Marion County: W. W. Gromman 2 W. P. Stiles, M. G. Nail Sur., pumped 27 bbl., pay 2,260 ft., T.D. 2,265 ft.

Coke, Wood County: Amerada Pet. 1 Bessie Conner, Berry Smith Sur., elev. 525 ft., flowed 110.6 bbl. in 6 hr. through ¼-in. choke, perf. casing 6,360-70 ft., T.D. 6,375 ft.

Hawkins, Wood County: Magnolia Pet. 3 C. W. B. of M., S. Castleberry Sur., pumped 140 bbl. in 18 hr., perf. casing 4,680-4,722 ft., T.D. 4,847 ft.

Louisiana Gulf Coast

(Continued from Page 174)

750,000 cu. ft. dry gas through ⅛-in. and ¼-in. chokes on tubing, T.P. 350 lb., C.P. sealed, T.D. 1,496 ft., P.B. to 1,010 ft.

Fields

Bayou Sale, St. Mary Parish: Humble 1-E Miami Corp., 43-16s-9e, O.W.W.O., old T.D. 11,102 ft., P.B. to 10,335 ft., 27 bbl. through 7/64-in. choke, T.P. 2,900 lb., C.P. sealed, gas-oil ratio 19,250:1.

South Roanoke, Jefferson Davis Parish: Union Sulphur 1 Kelly-Weber, 23-10s-4w, location abandoned.

Venice, Plaquemines Parish: Tide Water 7 Manhattan Land & Fruit Co., 26-21s-30e, O.W.D.D., old T.D. 7,205 ft., drilled to T.D. 8,509 ft., 170 bbl. through ⅛-in. choke on tubing, T.P. 900 lb., C.P. sealed, gas-oil ratio 441:1.

Ville Platte, Evangeline Parish: Texas 5 E. B. Norman, 195 bbl. through 10/64-in. choke, T.P. 1,090 ft., C.P. sealed, gas-oil ratio 935:1, T.D. 10,241 ft.

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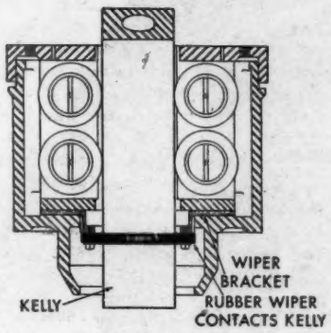

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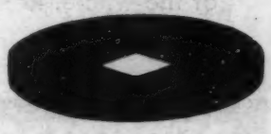

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"If a Kelly Wiper is used, the weight indicator works much more accurately," says an Engineer for one of the largest oil companies operating in Louisiana.

Without a Kelly Wiper, mud clogs the rollers after enough has packed in so there is a drag on the Kelly which may mean as much as four points weight on the scale. When the scale reads the two points wanted for drilling there may be as much as six points on the bit which may mean the difference between a straight and crooked hole.

PATTERSON-BALLAGH CORPORATION
Los Angeles Houston New York City

USE PATTERSON-BALLAGH RUBBER KELLY WIPERS

TEXAS GULF COAST

Flowing Well Opens New Jackson County Field

By T. F. SMILEY

HOUSTON, Tex.—Renwar Oil Corp. 1 O. W. Freeman, which sets up a new field for Jackson County, was flowing at the rate of 168 bbl. a day through ⅞-in. tubing choke as the week closed. The well was drilled to a total depth of 6,651 ft., where pipe was cemented, with perforations at 6,644-48 ft. Tubing pressure was 1,700 lb. and casing pressure 2,400 lb.

E. O. Ehlinger et al 1 Gibbs Brothers, a Walker County wildcat 4 miles south of Huntsville, in the John Fox Survey, was finished dry at a total depth of 7,512 ft. A show was found at 7,000-10 ft. The Discorbis Jacksonia was penetrated at 2,102 ft., Textularia Hockleyensis 2,320 ft., Textularia Dibollensis 2,934 ft., Cockfield 3,091 ft., Ceratubulimina 4,230 ft., Wilcox 5,880 ft.

Crude Oil and related raw materials travel devious roads during conversion by the great Petroleum Industry into finished products for the consumer. A bank in tune with the other integral parts of the processing program is an indispensable unit of the whole. Republic National Bank will be found performing an important function at every step.

REPUBLIC NATIONAL BANK
OF DALLAS
MEMBER FEDERAL DEPOSIT INSURANCE CORP

ONE OF THE NATION'S 100 LARGEST BANKS

In the new Mustang Creek field opened by Guy Warren 1 Freeman in the William Menefee Survey of Jackson County, the same operator has staked location for his 1 Camille Smith, 2,000 ft. northeast of the discovery.

Texas Co. brought in two producers in the Mayo field of Jackson County, both in the Morris and Cummings Survey. One, 5 F. V. Tunison, flowed 112 bbl. through ⅛-in. choke, and the other, 7 F. V. Tunison, flowed 117 bbl. through ⅛-in. choke.

Glenn H. McCarthy et al have staked location for 1 Maco Stewart, which is to be a deep test east of the Hitchcock production in Galveston County. The site is about 2,000 ft. east of Shell's recent test, which blew out of control.

Texas 2 O. D. Collier, in the James Kerr Survey of Jackson County, was flowing at the rate of 96 bbl. a day through 11/64-in. choke on tubing. Tubing pressure was 290 lb. and casing pressure, shut in, 360 lb. It is still testing as the week closed.

Much geophysical work is being done in the Gulf Coast area. Two crews are working in Brazoria County, two in Chambers County, several in Fort Bend County, and at least one crew is working in almost every county in the territory.

TEXAS GULF COAST COMPLETIONS

Wildcats

Jackson County: W. S. Boyle 1 J. M. Heard, F. Menefee Sur. A-51, 4 mi. E of Ganado, no shows in series of tests, dry at 6,010 ft.

Walker County: B. A. Fennell 1 Fraser & Campbell, W. N. Mock Sur. A-401, 4 mi. S of Huntsville, location abandoned.

E. O. Ehlinger et al 1 Gibbs Bros., John Fox Sur. A-200, 4 mi. S of Huntsville, 6,859-79 ft. salt-water sand, 6,879-89 ft. no show, 7,000-10 ft. show, top of Wilcox 5,880 ft., dry at 7,512 ft.

Fields

Chocolate Bayou, Brazoria County: Phillips 1 Andrau Bernerdina, dry at 12,005 ft.

Clodine, Fort Bend County: Wynn Crosby Drilling Co. 1 Morrison et al, 140 bbl. through ⅛-in. choke, T.P. 2,300 lb., C.P. 2,500 lb., gas-oil ratio 1,500, T.D. 7,555 ft.

Dickinson, Galveston County: Mid-States 1 Maco Stewart, Unit 1, 63 bbl. distillate through ⅞-in. choke, T.P. 2,900 lb., C.P. 800 lb., gas volume 2,800,000 cu. ft., T.D. 8,607 ft.

Esperson, Liberty County: General Crude Oil Co. 1 Stanolind fee, 424 bbl. through ¼-in. choke, T.P. 2,200 lb., C.P. 2,550 lb., gas-oil ratio 3,781:1, T.D. 8,304 ft., P.B. 8,225 ft.

Fig Ridge, Chambers County: Cox & Hamon 2 Janet McCarthy, location abandoned.

Goodrich, Polk County: Pan American 4-B Texas Long Leaf Lumber Co., dry at 7,610 ft.

Harmon, Jackson County: Gulfboard Oil Corp. et al 1 McCrory-Westhoff, 81 bbl. through ⅞-in. choke, T.P. 300 lb., C.P. sealed, gas-oil ratio 751:1, T.D. 5,578 ft.

Mayo, Jackson County: L. Crouch 1 L. K. Kahanek, 77 bbl. through 3/32-in. choke, T.P. 425 lb., C.P. 1,100 lb. sealed, gas-oil ratio 416:1, T.D. 5,567 ft., P.B. 5,535 ft.

Texas 5 F. V. Tunison, 112 bbl. through ⅛-in. choke, T.P. 600 lb., C.P. sealed, gas-oil ratio 366:1, T.D. 5,600 ft., P.B. 5,428 ft.

Texas 7 F. V. Tunison, 117 bbl. through ⅛-in. choke, T.P. 630 lb., C.P. sealed, gas-oil ratio 356:1, T.D. 5,460 ft.

North Bay City, Matagorda County: Ohio 2 E. L. McDonald, O.W.W.O., 104 bbl. through 10/64-in. choke, T.P. 450 lb., C.P. 1,200 lb. S.I., gas-oil ratio 736:1. T.D. 8,846 ft.

Oyster Bayou, Chambers County: Sun 12 Felix Jackson, 150 bbl. through ⅛-in. choke, T.P. 2,050 lb., C.P. 800 lb., gas-oil ratio 1,493:1, T.D. 8,385 ft.

Sour Lake, Hardin County: E. C. Hankamer et al 1 Charles G. Hooks, 149.83 bbl. through 5/32-in. choke, T.P. 260 lb., C.P. 800 lb., gas-oil ratio 150:1, T.D. 3,083 ft.

Spindletop, Jefferson County: Stanolind 105 Gladys City, O.W.D.D., old T.D. 4,809 ft., P.B. to 2,600 ft., drilled to new T.D. 4,908 ft.

West Ranch, Jackson County: Abe Seibel 1 Bennview Development Co., O.W.W.O., 81 bbl. through ⅛-in. choke, T.P. 440 lb., C.P. 325 lb., gas-oil ratio 410:1, T.D. 5,604 ft.

Rocky Mountain Area

(Continued from Page 168)

known as the Osgood anticline, 6 to 8 miles northwest of the Greasewood field. This structure has appeared on a number of maps but until now efforts to block it up have been unsuccessful. The principal acreage is owned by Frank Kirchoff, a Denver banker, with whom Ramsey was able to make a deal. Location of test has not yet been announced.

NORTH LOUISIANA. ARKANSAS

First Oil Discovery Reported In Northwestern Florida

EL DORADO, Ark.—Activity in Arkansas still centers around the New London pool of Union County. The Marine Oil Co., having extended the field to the north last week, has obtained permits for two new wells in this area. These are the 6 and 7 Frost in the SE SE 12-18s-12w and NE NE of 13-18s-12w. Southern Arkansas' present wildcat activities are centered in Calhoun and Bradley counties. Placid Oil Co. staked two new tests on the Freeman-Smith Lumber Co. land in 24-15s-13w and 12-15s-14w; the first being 3 miles northwest of the town of Artesia and the latter located some 7 miles northwest of the same company's 1 Louisiana Lumber Co., NE SE 11-16s-12w, which was dry at 5,050 ft.

Production of crude oil and condensate from the 35 oil and gas pools in South Arkansas for the month of September averaged 73,875 bbl. daily, an increase of 1,372 bbl. over the August production, according to the Arkansas Oil and Gas Commission. Arkansas' recommended production for December was set at 77,300 bbl. by OPC, an increase of 100 bbl. daily over November.

NORTH LOUISIANA COMPLETIONS

Wildcat, Caldwell Parish: J. W. Love 1 Louisiana Central, N½ NE SE 29-13n-4e, dry, T.D. 4,570 ft.

Wildcat, East Carroll Parish: Roeser & Pendleton 1 J. L. Logan, 14-23n-13e, dry, T.D. 6,007 ft.

Wildcat, Claiborne Parish, 12 mi. E of Haynesville: Houston & Weiner 1 Wilson, N½ SE NE 6-23n-5w, dry, T.D. 5,200 ft.

Haynesville, Claiborne Parish: Cook & Johnston 1 Knox, SW SE 17-23n-8w, flowed 100 bbl., Pettit 5,392-98 ft., 5,418-26 ft., 5,440-56 ft., T.D. 5,528 ft.

F. R. Sylvestre 1 Waller, SW NW 25-23n-8w, flowed 792 bbl., Pettit 5,416-36 ft., 5,480-84 ft., T.D. 5,505 ft.

Hosston, Caddo Parish: Bayou State Oil 4 A Brown, SW SW SE 21-22n-15w, pumped 5 bbl., T.D. 1,028 ft.

Monroe, Union Parish: United Carbon 10-C Union Power, W½ SW 21-21n-3e, 8,015,000 cu. ft. gas, T.D. 2,183 ft.

United Carbon 9-C Union Power, S½ NW 21-21n-3e, 8,690,000 cu. ft. gas, T.D. 2,183 ft.

J. E. Farrell 1 Union Producing fee, N½ SE 33-21n-4e, 5,667,000 cu. ft. gas, T.D. 2,135 ft.

ARKANSAS COMPLETIONS

Wildcat, Bradley County, 12 mi. N of New London: Placid Oil 1 Louisiana Lbr., NE SE 11-16s-12w, dry, T.D. 5,050 ft.

Smackover, Ouachita County: H. O. Davis et al 1 Cheatham, SW NE 27-15s-15w, dry, T.D. 4,908 ft.

Stephens, Columbia County: R. H. Crow 1-B Taylor, SE NE 12-15s-20w, pumped 129 bbl., Smart sand 3,103-14 ft., T.D. 4,032 ft.

G. H. Vaughn, Jr., 2 Green, NW SE 11-15s-20w, pumped 110 bbl., pay 2,469-90 ft., T.D. 3,415 ft.

FLORIDA

Reports received last week indicated that a well in Walton County, northwestern Florida, about 9 miles southeast of DeFuniak Springs, had been brought in and was shut in after flowing 150 bbl. of oil during the few minutes it required to cap the well. Although the state's $50,000 prize for the first commercial well has not been applied for, Herman Gunter, state geologist, was reported to be investigating the well. Description of the wildcat was given as Myers-Arrington-Sanford 1 Walton, 16-1n-18w. About 225 miles east, in Baker County, Tasse V. Orr 1 Marion Corp was dry at 2,640 ft.

FLORIDA COMPLETIONS

Baker County, about 2 mi. SE of town of Taylor in Baker County, northern Florida: Tasse V. Orr 1 Marion Corp., NW NE NE 11-1s-20w, dry, T.D. 2,640 ft.

Appalachian Fields

(Continued from Page 174)

Summit Gas & Development Co. 1 F. M. and Reva Riddle, drilled deeper, 112,000 cu. ft. gas, Big lime 1,295 ft., Injun 1,515 ft., Berea 1,997 ft., T.D. 2,028 ft.

Ritchie County, Grant district: F. S. Deem et al 27 Rutherford heirs (L. C. Stephens), 20 bbl., Maxton sand, T.D. 1,825 ft.

Leavitt & Black 1 Joseph Donnelly, dry, Maxton 1,438 ft., Big lime 1,498 ft., Injun 1,600 ft., T.D. 1,820 ft.

Taylor County, Booths Creek district: Pittsburgh & West Virginia Gas Co. 6131 Casper L. Curry, dry, Gantz sand 1,652-1,705 ft., fourth 1,990-2,004 ft., fifth 2,116-2,122 ft., T.D. 2,258 ft.

Wood County, Walker district: South Penn Natural Gas Co. 8 Monroe McPherson, 2 bbl. a week, Berea, T.D. 2,293 ft.

ORISKANY GAS FIELDS

Jackson County, Ripley district: United Carbon Co. 1607 Elizabeth W. Perkins, 6,250,000 cu. ft. gas, Oriskany 5,380 ft., shot 5,382-5,410 ft., R.P. 1,700 lb., T.D. 5,412 ft.

United Fuel Gas Co. 5116 D. C. Shamblen, 4,726,000 cu. ft. gas, Oriskany 5,041 ft., gas 5,042-49 ft., T.D. 5,051 ft.

United Fuel Gas Co. 5131 Mabel Fisher, dry, Oriskany 5,068 ft., 1½ bbl. water and ½ bbl. oil an hr. at 5,120-22 ft., T.D. 5,122 ft.

Kanawha County, Poca district: Columbian Carbon Co. 685 J. A. Dodd et al, dry, Oriskany 5,202-42 ft., lime break 5,242-57 ft., Oriskany 5,257-76 ft., T.D. 5,284 ft.

Diesel-Fuel Prices Adjusted

WASHINGTON, D. C.—Two new regulations by Office of Price Administration are designed to clarify the Gulf Coast bunker-oil situation.

Under Amendment 46 to Price Schedule 88, OPA established a uniform ceiling price of $1.10 per barrel for Bunker C and No. 6 fuel oil at Mobile, Ala. Previous ceiling of 85 cents was called "abnormally low" by OPA.

Under Amendment 47 to the same schedule, OPA said:

"Clarification and adjustment of dollar and cents ceilings for distillate and residual diesel oils, ships' bunkers, on the Texas-Louisiana Coast were made . . . by the OPA. Effective November 25, the ceiling for residual diesel, 26 A.P.I. gravity and below, ships' bunkers, will be $1.35 a barrel, while the maximum price for distillate diesel, 28 A.P.I. gravity and above, will be $1.65, ships' bunkers, for the area."

FOR DRILLING

and other Oil Field Operations

Use Natural Gas

FOR DRILLING . . . Natural Gas presents no fuel storage problem. It is always ready and its ease of handling promotes maximum efficiency at the rig.

FOR REPRESSURING AND LEASE OPERATIONS . . . Natural Gas is economical and dependable.

We will welcome an opportunity to serve you in your drilling or other oil field operations in the Gulf South. A phone call or letter to any of our offices* or employes will receive prompt attention.

*TEXAS: Beaumont, Beeville, Dallas, Fort Worth, Houston, Longview, San Antonio and Wichita Falls. LOUISIANA: Baton Rouge, Iowa, Monroe and Shreveport. MISSISSIPPI, ALABAMA and FLORIDA: Jackson, Mississippi.

UNITED GAS PIPE LINE COMPANY

OHIO, INDIANA, KENTUCKY

Brush Creek and Zoarville Gas Fields Extended

ZANESVILLE, Ohio—Two gas fields have been extended this week. The Brush Creek field of Muskingum and Morgan counties was extended 2½ miles to the east by the completion of the Industrial Gas Corp. 1 Charles Reeder, NE Section 4, Bloom Township, Morgan County. The Clinton sand was found at 4,425-80 ft. The well had an open flow of 800,000 cu. ft. after shot and a rock pressure of 1,140 lb. At Zoarville in Fairfield Township, Tuscarawas County, J. A. Upham completed a well on the Lloyd Murphy tract, Section 22, good for 898,000 cu. ft. of gas from the Clinton sand at 5,226-69 ft., with a rock pressure of 1,340 lb. This well extended the field 2½ miles to the southeast.

Sinclair Prairie is drilling 1 George Longsworth, Section 22, Olive Township, Meigs County, to the Clinton sand.

OHIO COMPLETIONS

Athens County, Carthage Township: H. B. Walker 1 Lewis Hounestine, Sec. 32, dry, Berea, T.D. 1,665 ft.

Coshocton County, Perry Township: Wittmer Co. 1 Ensil Donaker, Sec. 23, dry, Clinton, T.D. 3,200 ft.

Fairfield County, Pleasant Township: City Nat. Gas Wks. 2 W. McCandlish, Sec. 25, 126,240 cu. ft., Clinton, T.D. 2,477 ft.

Gallia County, Greenfield Township: Portage Producers 22 Cambria Clay Prod. Co., Sec. 19, dry, Clinton, T.D. 3,020 ft.

Knox County, Union Township: Earley et al 2 H. G. Hammond, Sec. 24, dry, Berea, T.D. 770 ft.

Lorain County, Pittsfield Township: Ohio Fuel 1 H. Stoddard, Lot 142, 970,000 cu. ft., Clinton, T.D. 2,323 ft.

Ridgeville Township: Edson & Son 1 H. W. Dyke, Lot 45, dry, Clinton, T.D. 2,419 ft.

Medina County, Spencer Township: Ohio Fuel 1 Cecil Evans, Sec. 16, Spencer, dry, Clinton, T.D. 2,723 ft.

Meigs County, Rutland Township: H. M. Nelson 2 Jas. A. Woodard, Sec. 27, 90,000 cu. ft., Maxon, T.D. 729 ft.

Morgan County, Bloom Township: Industrial Gas 1 Chas. Reeder, Sec. 4, 800,000 cu. ft., Clinton, T.D. 4,491 ft.

Muskingum County, Salt Creek Township: Ohio Fuel 2 M. E. Powelson, Sec. 5, 425,000 cu. ft., Clinton, T.D. 4,120 ft.

Noble County, Marion Township: Warren et al 1 M. R. Franklin, Sec. 2, dry, Berea, T.D. 1,708 ft.

Perry County, Clayton Township: Pure Oil 6 Jas. Pargeon, Sec. 7, 127 bbl., Clinton, T.D. 3,265 ft.

Stark County, Pike Township: Lyons et al 1 J. J. Ewing, Sec. 10, 476,000 cu. ft., Clinton, T.D. 4,832 ft.

Tuscarawas County, Fairfield Township: J. A. Upham 1 Lloyd Murphy, Sec. 22, 898,000 cu. ft., Clinton, T.D. 5,313 ft.

Washington County, Fearing Township: E. W. Hass 6 Chas. Kuntz, Lot 100, 5 bbl., Macksburg 500 ft. sand, T.D. 802 ft.

Salem Township: R. L. Smithberger 2 Daniel Ullman, Sec. 35, dry, Berea, T.D. 1,780 ft.

INDIANA

EVANSVILLE, Ind.—About 6 miles south of Mount Vernon, the Sohio Producing Co. and C. E. Brehm are preparing to set casing to test saturation encountered in the McClosky lime at 2,577-81 ft., 2,629-34 ft., and 2,713-17 ft. Pipe is to be set at the total depth of the hole, 2,796 ft., and operators plan to perforate the casing opposite the pay zones. The test is the 1 Reis Eilert, SE NE NW 18-8s-13w, and is about 1 mile southeast of the Hovey Lake pool, consisting of one well recently drilled by the Sohio Producing Co. and C. E. Brehm, and completed in the Mansfield sand.

In Spencer County, W. W. Damron and Gary have abandoned the 1 E. L. Hall, NW NW SW 34-7s-7w, as dry at a total depth of 1,706 ft. after failing to find a McClosky section in the well. The same operator's 1 W. H. Jones, NW NE SW 34-7s-7w, also in the Eureka pool, is shut down at 723 ft., and the E. E. Schaaf et al 1 Wilderson, NE NW NW 2-8s-7w, is shut down at 1,396 ft.

INDIANA COMPLETIONS

Daviess County: R. C. McClellan 1 Quigley, NW SE SW 5-2n-5w, dry, T.D. 670 ft.

Gibson County: Continental 57 Maier, N½ NW 6-3s-13w, pumped 170 bbl., Cypress 2,474-99 ft., T.D. 2,500 ft.

Carroll Oil 1 Crecelius, NW SE 36-1s-10w, dry, T.D. 1,333 ft.

Carroll Oil 2 Crecelius, NW NW SE 36-1s-10w, flowed 20 bbl., natural, sand 1,304-10 ft., 1,316-22 ft., T.D. 1,338 ft.

K. D. Holland 1 Harrall-Fulton, SW NW NW Don. 97-1n-10w, dry, T.D. 1,788 ft., McClosky 1,774 ft.

Owen County: Sun Oil 1 Chambers, E½ SW SE 23-10n-5w, T.D. 3,199 ft.

Posey County: W. C. McBride 1-B Suonder, NW SW SW 3-4s-14w, dry, T.D. 3,002 ft., Aux Vases 2,823 ft.

Spencer County: N. C. Detrick 1 Krausch, SW SW NE 33-6s-5w, dry, T.D. 1,177 ft., McClosky 1,096 ft.

Vanderburg County: Sells Pet. 3-A McCarthy, NW NE NW 32-6s-11w, pumped 60 bbl., natural, Waltersburg sand 1,778 ft., T.D. 1,792 ft.

EASTERN KENTUCKY

ASHLAND, Ky.—One gas well was completed and one dry hole reported in eastern Kentucky this week as operations again displayed a slight increase. Two new locations were reported in one field and a report of activities shows that at least four or five wells are nearing completion stage and should be drilled in by the end of the month or sooner.

EASTERN KENTUCKY COMPLETIONS

Floyd County: Kentucky-West Virginia Gas Co. 5425, Wilson Hall land on Frazier Creek, flowed 427,000 cu. ft. gas, T.D. 2,973 ft. in shale.

Martin County: Kentucky-West Virginia Gas Co. 5421, W. B. Preece tract on Coldwater Fork, dry, T.D. 2,936 ft. in shale.

Oklahoma Fields

(Continued from Page 169)

3,479-89 ft., T.D. 3,502 ft., 1,250 lb. R.P.

Cumberland, Marshall County: Pure Oil 5 Little-101, SE SW SE 28-5s-7e, flowed 300 bbl. through choke, Oil Creek 5,665 ft., T.D. 5,777 ft.

Okemah, North, Okfuskee County: British American 1-A Martin, SW SE SE 35-12n-9e, pumped 20 bbl., Gilcrease sand 3,112 ft., T.D. 3,165 ft.

British American 1-B Bloss, SW NE SW 36-12n-9e, flowed 220 bbl., Gilcrease 3,112 ft., T.D. 3,151 ft.

Keener et al 2-A Parsons, SE SW NE 36-12n-9e, dry, T.D. 3,155 ft.

Watchorn, East, Pawnee County: J. E. Crosbie 1 Doyle, SW NW NW 36-23n-3e, flowed 432 bbl., Wilcox 3,893 ft., T.D. 3,912 ft.

Alma Oil 2 Robedeaux, SW SE SE 26-23n-3e, flowed 45 bbl., Wilcox 3,951-55 ft.

Wewoka townsite, Seminole County: Jaligon 1 fee, S½ NW NW 16-8n-8e, swabbed and flowed 240 bbl., Hunton 3,976 ft., perf. 3,975-85 ft., T.D. 4,280 ft.

Miscellaneous

Creek County: Joe Britton 2 Wright, S½ SW SE 17-17n-8e, pumped 25 bbl., Prue 2,334 ft., T.D. 2,348 ft.

Hughes County: Four States Oil & Gas 1 Field, SW NE NW 26-9n-11e, dry, T.D. 2,866 ft.

Sequoyah County: Western Oklahoma Gas 1 Brant, SE SE 18-10n-26e, 330,000,000 cu. ft. gas, sand 1,790 ft., T.D. 2,004 ft.

Stephens County: Skelly 29 Franklin, SW NE SE 35-1s-5w, dry, T.D. 960 ft.

Fair & Bright 1 Binder, SW SE SE 36-2s-6w, flowed 6 bbl., sand 1,082-92 ft., T.D. 1,508 ft.

CANADIAN FIELDS

Interest in Southwest Turner Valley Extension Revived

By VICTOR LAURISTON

CHATHAM, Ont.—Crude and natural-gasoline production from all Alberta fields for the week ending November 9 averaged 27,406 bbl. daily, compared with 27,020 bbl. daily for the previous week and 27,076 bbl. daily for the corresponding week last year. The daily average included 26,272 bbl. of crude and 669 bbl. of natural gasoline from Turner Valley and 465 bbl. of crude from outside fields.

Turner Valley Outposts

Completion of Northwest-Hudson's Bay 8, LSD 2-3, 8-18-2w5, at 8,645 ft. total depth with initial production of 557 bbl. daily has aroused new interest in the southwest extension of the field. This is the most southerly of seven wells drilled by Northwest-Hudson's Bay in 8-18-2w5, all finishing producers. No. 8 got the Madison lime at 8,214 ft. with the upper and lower zones at a normal depth in the lime. As a result, Brown Oil Corp. 6, LSD 15, 5-18-2w5, standing for more than 3 years at 4,517 ft., will be deepened to test the lime. Brown 6 was started in June 1939, in the Bearpaw formation, with upper Benton at 2,210 ft., but faulted back to Belly River at 3,040 ft. Location is ¼ mile southeast of Northwest-Hudson's Bay 8 and it is now believed the well has a good prospect of getting production in the lime. Northwest-Hudson's Bay 12 is drilling farther north and east, in LSD 8, 8-18-2w5.

The eastern flank of North Turner Valley, heretofore regarded as a potential gas-naphtha area, will be tested by Royalite Oil 66, spotted in LSD 3, 34-20-3w5. Prospects for this area east of the proven crude production were considerably improved by completion of Major Oils 9, LSD 1, 4-21-3w5, as a good producer. Royalite 66 is ½ mile east and about 1 mile south of Major 9, and immediately south of Calmont-Millarville 1, LSD 6, 34-20-3w5, which is logging high, with the upper Blairmore at 2,420 ft. Proving the east flank of North Turner Valley would open a considerable number of drilling locations and offset the negative results in the deep drilling area of the North Turner Valley extension.

There is considerable activity among outpost tests northwest of the North Turner Valley producing area. Most northerly of these is Bonaventure 1, LSD 16, 24-21-4w5, now below 6,873 ft. with the Benton-Blairmore contact reported at 6,730 ft. Location is 2 miles north and 1¼ miles west of the most northerly production.

Eastern Alberta

In the Vermilion field, eastern Alberta, Tenwell Gas & Oil 1, LSD 9, 36-50-7w4, is being abandoned to salvage casing. This well, started by a Vermilion group in 1935, was the first test of the Vermilion area. It encountered five gas and three oil shows, but failed to develop commercial production, the actual field being developed a few years later to the southeast.

In the Wainwright field efforts are being made by the Standard refinery at Wainwright to recondition the old Hargal Oils 3 well and restore it to production. The test got good oil shows in the Cretaceous

(Continued on Page 187)

KANSAS, NEBRASKA

Butler County May Have New Arbuckle Lime Pool

By CARL HOOT

IN Butler County, about 2 miles south of the Douglas Lansing-Kansas City lime area, a new Arbuckle lime pool was in sight when Deep Rock Oil Corp. 1 Eckle, E½ SE NW 32-29-4e, found pay at 2,951-56 ft., set casing at 2,951 ft. and when the plug was drilled oil rose 2,000 ft. in the hole. The well was shut in for the erection of storage tanks before production tests could be made.

In Stafford County, 6 miles west of Drach, Vickers Petroleum Co. 1 Curtis, S½ SW NW 6-22-13w, opened the Seward pool with the maximum allowable potential of 3,000 bbl. Pay zone is the Arbuckle lime at 3,693-3,700 ft. After setting 5-in. casing at 3,693 ft., 30.6-gravity oil filled the hole in 7 hours and on swabbing tests the oil could not be lowered more than 1,600 ft. off bottom. A number of offset locations had been staked by the end of the week.

In Sumner County the Padgett pool was extended 1 mile west at its southern tip when E. B. 1 Chandler, a wildcat in SW SE 4-35-2e, pumped 20 bbl. of oil a day from Mississippian chat at 3,414-93 ft. Production at Padgett, an old area, is also found in the chat at an average depth of 3,474 ft.

KANSAS COMPLETIONS

Wildcats

Cowley County: Zephyr Drlg. 1 Stout, NW NW SW 20-33-5e, dry, T.D. 3,619 ft., Layton 2,393 ft., Bartlesville 3,093 ft., Arbuckle 3,596 ft.

Marion County: Wolf Creek Oil 1 Mehl, NE SW SW 5-20-5e, dry, T.D. 2,544 ft., Lansing 1,725 ft., Mississippi lime 2,230 ft., Viola 2,518 ft.

McPherson County: Derby Oil et al 1 Johnson, S½ SW SE 35-17-2w, dry, T.D. 3,416 ft., Mississippi lime 2,825 ft., Hunton 3,135 ft., Viola 3,266 ft., Arbuckle 3,392 ft.

Nemaha County: Clifton, Gall & Tolle 1 Mills, SE NE 24-1-14e, dry, T.D. 2,946 ft., Lansing 1,277 ft., Hunton 2,890 ft.

Stafford County: Vickers Pet. 1 Curtis, S½ SW NW 6-22-13w, 3,000 bbl. initial potential, Arbuckle 3,693-3,700 ft., discovery.

Herndon Drlg. 1 Suiter, SW SE NW 9-25-15w, dry, T.D. 4,566 ft., Lansing 3,817 ft., Viola 4,313 ft., Simpson 4,456 ft., Arbuckle 4,536 ft.

Sumner County: E. B. Shawver 1 Chandler, SW SE 4-35-2e, pumped 20 bbl., Mississippi lime 3,414-93 ft.

Fields

Bemis, Ellis County: Cities Service 1-B Johansen, E½ NE NW 34-11-17w, 3,000 bbl., Arbuckle 3,594-98 ft.

Gibson, Cowley County: Sinclair Prairie 3 Shurtz, NW SW NE 29-34-3e, pumped 73 bbl., Bartlesville 3,364-81 ft.

Hugoton, Haskell County: United Producing 1 Poncet, approx. C 19-29-34w, 1,500,000 cu. ft. gas, Winfield 2,535-2,735 ft., T.D.

Laton, Rooks County: Vickers Pet. 2 Reese, NW SE 3-9-16w, pumped 179 bbl., Lansing 3,115-63 ft.

Linwood, Leavenworth County: Miller 1 Mills, SW SE 30-11-22e, dry, T.D. 675 ft.

Lost Springs, Marion County: Kuhn Bros. 1 Holob, SE SE 32-17-4e, pumped 168 bbl., Mississippi lime 2,395-2,417 ft.

McLouth, Leavenworth County: C. W. McKnabe 1 Kessinger, NW SW 1-10-20e, 724,000 cu. ft. gas, sand 1,381-86 ft.

Mosbacher 2 Bell estate, SW NW SW 6-10-21e, dry, T.D. 1,438 ft.

Morel, Graham County: Barnsdall 2 Davignon, SE SW 11-9-21w, dry, T.D. 3,787 ft., Arbuckle 3,709 ft.

Cities Service 1-A Sutor, NW NE SE 22-9-21w, 3,000 bbl., Arbuckle 3,803-85 ft.

Peace Creek, Reno County: Sinclair Prairie 3 Baughman, SW SE NE 1-23-10w, pumped 84 bbl., Viola 3,709-43 ft.

Quincy, Greenwood County: Ed Ashlock 1-A Dinius, NW SE SW 31-24-13e, pumped 30 bbl., sand 1,480-91 ft., 1,687-90 ft., T.D.

Trapp, Russell County: Coralena Oil 4 Holland, N½ NW SW 16-15-13w, pumped 15 bbl., Lansing 3,065-90 ft.

B. & R. Drlg. 1 Tittle, S½ SE SE 14-15-14w, pumped 84 bbl., Arbuckle 3,361-71 ft.

Phillips 3 Maier, SE NE 15-15-14w, pumped 74 bbl., Arbuckle 3,272-78 ft.

Vernon North, Sumner County: E. B. Shawver 1 Waggoner, NW NW 16-35-2e, pumped 20 bbl., Mississippi lime 3,331-80 ft.

Weathered, Cowley County: Bess & Gralapp 2 Vallweider, NW SW 4-32-3e, water-disposal well, T.D. 3,553 ft.

NEBRASKA

ST. JOSEPH, Mo.—Cities Service Oil Co. has set surface casing in its 1 Jim Cook in NW NW NW 32-65n-39w, Atchison County, Missouri. This will be a Bartlesville test. It is a direct south offset to 1 Gray, which was a dry hole, but had a show of oil in the sand.

In Jefferson County, Kansas, the southeastern part of the state, M. Paul Steinberger and Allen Whiteside, both of Tulsa, are drilling 1 Guy Fry in NE NE SE 33-71n-9w, 7 miles southeast of Fairfield. Apperson 1 McLaughlin in SW NW NW 4-10s-20e, in the McLouth pool, had the Mississippi lime at 1,448 ft. and was drilling below 1,463 ft. with a show of oil.

Southwest Texas Fields

(Continued from Page 172)

ble 1 A. C. Soechting, the company's second test in the new field.

LOWER GULF COAST COMPLETIONS

Wildcats

Bee County: Magnolia 1 Buckner, T. Simons Sur., Lot 3, Sec. 6, dry at 10,561 ft., no pay.

San Patricio County: Henshaw Bros. 1 Tanherez, Cubbage-Miller subdivision of O'Connor ranch, Sec. 20, dry at reported depth of 6,185 ft.

Fields

Agua Dulce, Nueces County: L. M. Josey 1 H. C. Pyle, 98 bbl. through 7/64-in. choke, T.P. 625 lb., C.P. 850 lb., gas-oil ratio 760, T.D. 6,933 ft.

Richardson Petroleum Co. 2 Union Central Life Insurance Co., 139 bbl. through ¼-in. choke, T.P. 980 lb., C.P. 1,200 lb., gas-oil ratio 584, T.D. 7,200 ft.

Minnie Bock, Nueces County: Wellington Oil and Pan American 1-G Driscoll, 44 bbl. through ¼-in. choke, T.P. 590 lb., C.P. 120 lb., T.D. 3,800 ft.

Midway, San Patricio County: British American 3 Raymond Mullen, 133 bbl. through ¼-in. choke, T.P. 754 lb., C.P. 1,150 lb., gas-oil ratio 612, T.D. 6,137 ft.

South Caesar, Bee County: Luling Oil & Gas Co. 4-WB Tom Slick, dry at 6,634 ft.

Stratton, Kleberg County: Humble 19 King ranch-Paso Ancho, 119 bbl. through ¼-in. choke, T.P. 950 lb., C.P. 950 lb., gas-oil ratio 874, T.D. 6,604 ft.

SOUTH TEXAS COMPLETIONS

Wildcats

Duval County: Henderson Coquat 5-C Southland Life Insurance Co., Agua Foquita grant A-213, 3 mi. SW of Sweden townsite, oil odor 4,933-52 ft. and 5,065-71 ft., gas odor 4,953-63 ft., dry at 5,081 ft.

Jim Hogg County: Sun 1-D T. T. East, Santo Domingo de Arriba grant, 8 mi. E of Colorado field, 12.73 bbl. through ⅞-in. choke on tubing, T.P. 1,075 lb., C.P. 1,135 lb., gas-oil ratio 69,363 : 1, T.D. 5,503 ft.

H. B. Zachry Co. 1 C. Evers, James J. O'Connor Sur., 2½ mi. W of Colorado field, no shows, dry at 2,622 ft.

Sun 2 Well Bros., 17 mi. S of Hebronville, dry at 5,805 ft.

Live Oak County: Moore Development Co. 2 Otto Doebbler, S. A. Amonson Sur., Sec. 76, oil odor 2,510-18¼ ft., dry at 2,519 ft.

Fields

Colorado, Jim Hogg County: Sun 18 Thaxton, location abandoned.

Sun 19 Thaxton, location abandoned.

Kelsey, Brooks County: Humble 86 McGill Bros., location abandoned

Humble 87 McGill Bros., location abandoned.

Kreis, Duval County: Highland Oil Co. 1-D L. de la Garza, dry at 3,314 ft.

SOUTH CENTRAL TEXAS COMPLETIONS

Wildcats

Atascosa County: Humble 1 M. L. Thompson, Peter McGreel Sur. 1,293, Abst. 623, 1½ mi. SW of Vickers, pumped 38.15 bbl. oil and 70.85 bbl. salt water on 54-in. stroke, T.D. 7,576 ft.

Bastrop County: Taylor Refining Co. 1 C. C. Watterson, Andrew Mays Sur., dry at 3,722 ft.

Permian Basin, Panhandle

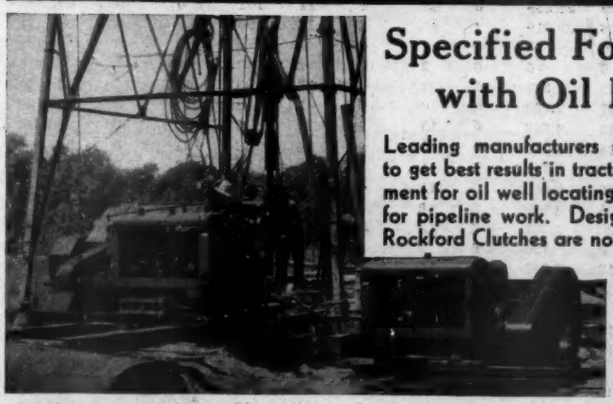
(Continued from Page 166)

Sec. 61, Blk. 3, elev. 3,047 ft., potential 93 bbl., pay 3,058 ft., T.D. 3,102 ft.

SOUTHEAST NEW MEXICO

HOBBS, N. M.—Drilling activity was reported to be on the increase over the past week throughout the Southeast New Mexico fields. Two pro-

Rockford Clutches



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Left: Rockford Spring-Loaded Clutch.

Right: Rockford Power Take-Off and Over-Center Clutch

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ducers and one dry wildcat test made up the week's completions. George F. Livermore, Inc., 1 J. C. Maxwell, NW NW 26-15s-34e, 6 miles north of the Vacuum pool in Lea County, was drilled to 6,004 ft. in lime and was dry.

Among the interesting wildcat tests, Olsen Oil Co. and Atlantic Refining Co. 1 Langlie, an 8,500-ft. Ordovician test in 11-25s-37e, just east of the shallow Langlie Permian pool of Lea County was drilling below 7,400 ft. in lime. Wildcats north of the proven area, and near the Texas State line reported steady progress. In Roosevelt County Malco Refining Co. 1 Bilberry was below 2,000 ft.

SOUTHEAST NEW MEXICO COMPLETIONS

Wildcat, Lea County: George P. Livermore, Inc., 1 Maxwell, NW NW 26-15s-34e, dry, T.D. 6,004 ft., salt 1,875 ft., Cowden anhydrite 2,650 ft., lime 4,555 ft.

Maljamar, Lea County: Maljamar Oil & Gas Corp. 11-A Mitchell, 17-17s-32e, flowed 100 bbl., pay 3,579 ft., T.D. 3,794 ft., shot 3,560-3,650 ft.

Square Lake, Eddy County: Texas Trading Co. 1 Grier, 29-16s-31e, flowed 150 bbl. through casing, shot 3,254-84 ft., T.D. 3,288 ft.

October Completions Down 51.2 Per Cent From Last Year

COMPLETIONS during the month of October were down 91 in comparison with last month. However, the difference in oil wells for the same period was three, with 16,147 bbl. initial potential less in October. Year-ago totals were 2,041, 287, and 645 for oil, gas, and dry, respectively, a decrease of 51.2 per cent for October 1942 completions.

There were 2,242 active rigs and drilling operations, a decrease of 138 over last month and 46.2 per cent under last year's total of 4,169.

Of interest is the fact that California operations have steadily increased over the past few weeks and this month's total of 99 completions is the highest since January. Completions in October 1941 were 91. This marked increase is due, in part, to renewed drilling in old shallow areas discovered as far back as 1900 and earlier. Such fields include Coalinga, South Belridge, Kern River, and Midway Sunset.

SUMMARY OF OPERATIONS, OCTOBER 1942

	Comp.	Oil	Prod.	Gas	Dry	Completions Under 1,000 ft.	1,000-2,500 ft.	2,500-5,000 ft.	5,000-10,000 ft.	Over 10,000 ft.	Footage	Drlg.
Appalachian	298	190	196	88	20	3	239	37	19	0	586,537	204
Ohio	115	26	830	39	50	10	36	68	1	0	316,751	201
Indiana	33	10	852	4	19	10	18	5	0	0	51,361	47
Kentucky	4	0	0	4	0	0	1	3	0	0	10,476	84
Michigan	46	15	2,162	7	24	0	22	24	0	0	116,921	116
Illinois	179	119	25,259	0	60	4	74	101	0	0	451,396	233
Kansas	110	66	28,319	4	40	2	12	93	3	0	360,411	181
Nebraska	1	0	0	0	1	0	1	0	0	0	2,491	16
Missouri, Iowa	3	0	0	0	3	1	2	0	0	0	5,414	2
Oklahoma	73	32	5,572	3	38	6	22	33	12	0	245,671	208
North Texas	73	27	7,876	0	46	5	41	16	11	0	189,136	61
West Central Texas	25	12	4,587	0	13	2	14	9	0	0	59,623	29
West Texas	83	68	38,625	0	15	0	14	38	31	0	348,706	106
Texas Panhandle	21	18	5,738	2	1	0	1	20	0	0	62,870	35
East Texas	39	26	6,916	0	13	1	1	17	18	2	218,456	30
Upper Gulf Coast	42	21	2,922	3	18	0	0	5	34	3	284,635	59
Lower Gulf Coast	35	20	2,462	3	12	0	1	5	24	1	205,064	43
South Central Texas	9	2	136	0	7	2	2	4	1	0	46,316	16
South Texas	29	18	2,620	0	11	1	6	19	3	0	93,874	55
SE New Mexico	17	16	1,760	0	1	0	0	16	1	0	64,458	49
Arkansas	13	8	1,653	0	5	0	0	3	10	0	82,584	30
North Louisiana	39	14	5,105	7	18	0	5	11	22	1	191,834	58
Louisiana Gulf	21	11	3,145	0	7	0	0	0	6	14	205,789	60
Mississippi	6	0	0	0	6	0	0	2	4	0	37,632	12
Montana	23	13	782	7	3	8	5	10	0	0	16,599	81
Wyoming	15	11	2,328	0	4	3	1	10	1	0	48,208	76
Colorado, Utah	3	1	90	0	2	0	1	0	2	0	45,425	36
NW New Mexico	0	0	0	0	0	0	0	0	0	0	0	9
California	99	86	14,915	1	12	13	33	35	16	2	286,538	101
Alabama	0	0	0	0	0	0	0	0	0	0	0	2
Florida	0	0	0	0	0	0	0	0	0	0	0	2
Total October	1,451	830	164,850	172	449	71	552	584	223	21	4,638,176	2,242
Total September	1,542	833	180,997	204	505	80	517	653	275	23	5,087,170	2,380
Difference	91	3	16,147	32	56	9	35	69	52	2	448,994	138

BOOK REVIEW

AERIAL PHOTOGRAPHS: THEIR INTERPRETATION AND USE. By A. J. Eardley.

A greatly expanded edition, the eighth, of the author's "Interpretation of Geologic Maps and Aerial Photographs," this is the first volume to be published in a series on Geoscience under the editorship of Dr. Carey Croneis of the University of Chicago. It sets a very high standard for the remainder of the series to follow.

The volume is roughly divided into two halves, of which the first deals with the preparation of maps from aerial photographs, stereoscopic methods and mosaics. The second half deals with the interpretation of culture and of geologic data as shown in the photographs. The author shows how geologic structures may be mapped, using maps and block diagrams to illustrate patterns of outcrops and presenting many photographs illustrating the way in which they are seen from the air. This is followed by a chapter dealing with less direct evidence, such as lines of demarcation between vegetation of different types of density, which variation is dependent upon the underlying formations. The use of aerial photographs in the preparation of structure contour maps is also covered and the final chapters deal with aerial reconnaissance and tactical interpretations.

Aerial Photographs: Their Interpretation and Use may be purchased through the Book Department of The Oil and Gas Journal at the established retail price of $2.75, postage prepaid (extra outside the United States), and a copy will be forwarded promptly upon receipt of check or money order for that sum. Where payment is not provided, the book will be sent c.o.d. to avoid delay.

STANDARD METHODS FOR TESTING PETROLEUM AND ITS PRODUCTS. (4th ed., 1942.) Institute of Petroleum, London, England. 400 pp., 97 diagrams. $3.

The new edition of this work represents a thorough revision of the majority of the methods described in the third edition and all those which have been published in the Journal of the Institute of Petroleum since 1935.

All methods have been rewritten, incorporating improvements developed since their last publication. Special attention has been given to the adoption of the International Standard definitions of accuracy, precision and tolerance.

An attempt has been made to include all test methods which are required in official specifications, and particularly those of the services. For example, the oxidation test required for aircraft lubricating oil to the British Ministry of Aircraft Production specification is now published in detail for the first time.

The usefulness of the book has been increased by the inclusion of methods of calculating diesel index and viscosity index, tables for the conversion of kinematic viscosity to Redwood viscosity, and also of various methods standardized by the American Society for Testing Materials.

FLUSH PRODUCTION. By Gerald Forbes. University of Oklahoma Press, Norman, Okla. 253 pp. $2.75.

This is the biography of the petroleum empire known as the Gulf-Southwest. From this area, comprising the six states of Kansas, Oklahoma, Texas, Arkansas, Louisiana, and New Mexico, comes three-fourths of the nation's oil. The story covers Southwestern oil from the time it was used as a medicinal cureall to the 100-octane gasoline, lubricants, and synthetics of today. The author approaches his historical sequence through the several phases of the industry—geology and exploration, discovery, drilling, production, refining, byproducts, transportation, application of science, conservation, social interpretation and folkways. This is a social history of oil. The author has served as a working newspaper man in several of the principal cities of the Southwest. More recently he has been a professor of history in Northeastern College at Tahlequah, Okla.

BIBLIOGRAPHY OF THE GEOLOGY AND MINERAL RESOURCES OF MONTANA: Montana Bureau of Mines and Geology, Butte, Mont. 350 pp. $3.

This is a highly technical publication containing abstracts of 1,980 articles; a description of Montana geologic formations and correlation tables; complete indexes, crossreferences and a stratigraphic chart. It is the first and only complete work of its kind dealing with Montana. It was compiled through the cooperation of the Montana Bureau of Mines and Geology, the Montana School of Mines, the Mining Association of Montana, and the Mineral Resources Survey.

Petroleum Rubber Program Progressing Satisfactorily

(Continued from Page 15)

priority ratings have been assigned and critical materials have been allocated, and the only bottleneck now is shop facilities for fabricating the equipment. Instead of moving the construction of all the butadiene plants along at about the same rate and sticking to the original schedule, the government expediters have concentrated on plants which were farthest along. This has not necessarily pushed back the completion dates of any of the other plants, but it has resulted in advancing a number of them.

One of the 20,000-ton alcohol butadiene plants at Institute, W. Va., scheduled for completion next January, will be in production before Christmas, to be followed shortly by another there originally scheduled for completion in February. In general the alcohol plants are farther along than the big petroleum plants, but several of the latter will be in production ahead of the contract dates if the present rate of speed continues.

Each 20,000-ton alcohol plant will consume 50,000 gal. of alcohol per day, and the rubber director has instructed the chemical branch of the War Production Board, as recommended by the Baruch report, to expand production of alcohol to be certain there is no shortage of raw material.

The amount of butylene to be required for butadiene, which is the feed stock for the largest share of the petroleum plants, has not been made public because of its close association with the 100-octane aviation-gasoline program. Butylene is essential to aviation gasoline, and there has been some fear that the two might conflict and a shortage of butylene would develop. The Baruch committee concluded that under the present aviation-gasoline program there would be sufficient butylene, and this is presently the opinion of the rubber director's office. Should the 100-octane program be expanded it is believed that additional catalytic cracking plants would have to be built anyway, so there is no present intention of reducing the segment of the butadiene program depending on butylene as the feed stock.

No Changes Now

The Baruch report recommended that no further changes be made in the synthetic-rubber program now, and this is being followed by the rubber director. No new butadiene plants have been scheduled since the rubber director was appointed, and none have been dropped. A number of new proposals for butadiene plants have been submitted, particularly one in connection with the new Kaiser steel plant at Fontana, Calif., but no contracts have been let. However, some changes in process or feed stocks may have to be made at certain places later on, such as in the plant of Southern California Gas Co. at Los Angeles which is scheduled to make butadiene out of distress motor gasoline and which may have to be converted to charge crude or other product.

The rubber director's office is assisting the Canadian Government in engineering work on a 30,000-ton butadiene and a 30,000-ton copolymerization plant to be erected at Sarnia, Canada, and while these figures are sometimes included in tabulations they rightly have no place in the United States program.

Almost every detail of the Baruch report is being followed religiously. The committee reported that the government-financed neoprene program was only 40,000 tons, supplemented by 9,000 tons from the plant owned by Du Pont Co., and recommended that the Government finance another 20,000 tons a year. This has been done. Neoprene makes excellent, though more expensive, tires, but its chief use for the present will be for military goods where its properties are superior to rubber.

The committee found that 24,000 tons of thiokol would be produced in 1943, all from privately owned plants, and recommended government contracts for 60,000 tons in order to provide material for civilian passenger-car tires and recaps. Such a contract has been negotiated with Dow Chemical Co.

Butyl-rubber production remains at 132,000 tons per year, and is scheduled to reach this rate early in 1943. Standard Oil Co. of New Jersey and affiliated companies have contracts for three 22,000-ton plants and one 66,000-ton plant. The butyl rubber will go chiefly into passenger-car tires.

No other types of synthetic rubber are in the program at present, nor are likely to be soon. The Baruch committee suggested a careful study of the possibilities of flexon, a quickly-made type of butyl requiring no critical equipment for plants but having inferior wearing qualities in tires. The rubber director has decided that flexon is wasteful of isobutylene and would require large quantities of dry ice in its production and that the rubber so produced would not be worth the cost in raw materials, so there is no flexon in the government program.

Other Research

Research is being conducted on several other types of synthetic rubber-like materials, such as noropol from soy-bean oil, but these are primarily long-range research projects, aimed at the production of specialty rubbers or postwar utilization of surplus commodities, and there is no immediate prospect that such new types of rubber will be produced in commercial quantities during the next year or two.

There is no perbunan (or buna-N) in the government program. Standard Oil Co. (New Jersey) has in operation a plant capable of producing 4,000 tons of perbunan annually, and this output is sufficient for the Government's needs for rubber with its peculiar properties such as for one of the layers in self-sealing airplane gasoline tanks.

Vistanex, koroseal, and various synthetic resins and plastics which replace rubber to some extent in various uses are being made by private companies and are not included in the government program.

Relatively small quantities of isoprene are being made under government contract by Hercules Powder Co. and Newport Industries, Inc., with turpentine as the raw material. About 3 per cent of isoprene is needed as a copolymer with isobutylene in producing butyl rubber, and is also used in compounding buna-S and neoprene to impart tackiness. Various other rubber chemicals probably will have to be purchased by Rubber Reserve Co., but there are no plans for government-owned plants to produce such materials. These would include soap or other emulsifying agents for copolymerization, and a wide variety of chemicals used in the fabrication of rubber goods such as carbon and other blacks, sulfur, plasticizers, accelerators, etc.

No new rubber-from-grain projects have been authorized. The entire 220,000 tons of butadiene to be made from alcohol will come from the process of Carbide & Carbon Chemicals Corp. Priorities have been granted for construction of a pilot plant by Publicker Commercial Alcohol Co. at Philadelphia, Pa., for study of the Polish process for making butadiene from alcohol, and similar pilot plants are under construction by the northern research laboratory of the U. S. Department of Agriculture at Peoria, Ill., and by Joseph E. Seagram & Sons, Inc., at Louisville, Ky., for experimentation with the process of making butadiene from butylene glycol fermented directly from grain.

Gulf Coast Refiners Look to South America for Crude

(Continued from Page 23)

total gasoline yield for the area is materially reduced. The experiences of one major refinery might illustrate the general change. A year ago the plant was making about 39 per cent motor gasoline and 2 per cent aviation gasoline. It was running about 100,000 bbl. of crude daily. Now, that plant is making only 24 per cent ordinary gasoline, 11 per cent aviation fuel and running only 82,000 bbl. of crude daily.

The desire to meet war needs by segregating and selecting certain crudes has not been practiced to as full a degree as many contend it should. Obviously, the production of crudes in many parts of the country from which Gulf Coast refiners draw their supplies is not conducive to an elaborate segregation and preferential program. It is quite definite, however, that certain refiners there are preparing to augment their normal preferential supplies of local crudes with oil produced in South America. To what extent this will be done will depend upon the available volume and characteristics of these oils needed to fit into the United Nations' war-production program.

The importance of the Gulf Coast refining area as a source of war products becomes apparent when the current military strategy of the United Nations is analyzed. The Gulf Coast is a logical supply source for troops fighting in northern Africa and in Mediterranean Europe.

Burner Oils

Gulf Coast refiners are faced with making maximum light-end products from limited quantities of preferential crudes, and, at the same time, recovering maximum yields of 50-cetane diesel oil.

This requirement is in direct conflict with making a maximum yield of high-octane gasoline from the same crude, so the working out of a careful operating program on the Gulf is necessary, if the best war production arrangement is to be realized. This idea is blunted by the fact that some of this diesel oil will be taken from the normal yield of household burning oils. This comes at a time when normally, refiners would be reducing gasoline and kerosene yields to make large quantities of burner oils. Thus the plan of making 50-cetane diesel oil taken largely from burner oils at a time when larger quantities of distillate fuels are wanted, makes the program complicated and difficult.

Over the past 10 years Gulf Coast refineries have been increasing in size, number and scope of operations. Because this growth has come in recent years, the average age of Gulf Coast refinery operators falls well within the selective-service range. Personnel turnovers of 20 per cent are being experienced; and this fact, together with the refiners' program to expand operations to make maximum quantities of war materials, is calling for the hiring of large numbers of women whose services are proving satisfactory.

The women are performing tasks of all kinds. One plant has 45 women working on "yard" jobs. These women pass through a training period of 6 to 12 weeks in a school operated independently of the refinery and their training is not all of the clerical type. One of the best-attended classes for women in refinery training is that in welding. This includes a desirable balance between refinery welding of metal and class-room lectures and discussion. At present one plant has 158 women employed in many kinds of work inside its gates and is prepared to provide women in many other jobs as men leave them for military service.

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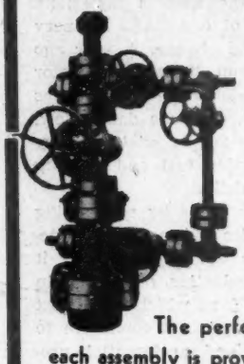

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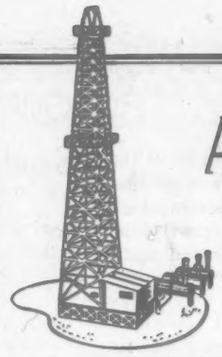


Among the Drilling

BROWN & PHILLIPS, drilling contractors of Falls City, Neb., have moved a portable rotary to the site of Cities Service Oil Co. 1 Jim Cook, NW 32-65n-39w, Atchison County, Northeast Missouri, and were to start drilling at once.

DAVIS Drilling Co. has the contract to drill the Keener Oil & Gas Co. 1 Jennie Anderson, NE SW NE 28-15n-1e, in southeastern Logan County, Oklahoma. Pits and cellar have been started. The test will drill to the second Wilcox sand. The deal was put through by Eli D. Bernstein, O. M. Cole and H. F. Elsey, all of Oklahoma City, Okla.

HELMERICH & PAYNE, which firm has contract for R. Olsen Oil et al 1 Justis, C SE SE 11-25s-37e, deep project on the east flank of the Langlie field, Lea County, New Mexico, was drilling below 7,339 ft. in lime, on an 8,500-ft. contract.

JOCK GARDEN, contractor of Hutchinson, Kans., has started rigging up for a test to be drilled a mile east and a mile south of Wymore, Gage County, Nebraska. A group from Lincoln is reported to be sponsoring the test.

W. L. PATRICK, of Houston, Tex., last week was moving in materials for a Smith County, Texas, wildcat test 1½ miles north of Sand Flat. Planned to test the Travis Peak, the test is expected to be taken between 9,000 and 10,000 ft. Nearest production is the Hawkins pool in Wood County.

P. H. PEWITT, Longview, Tex., has filed application for permit to drill on the Pickering Lumber Co. land, Milton Cook Survey, Shelby County, Texas. The test will be carried to the Travis Peak around 7,500 ft.

OTTO CALVIN has contract for J. Ben Russell 1 Campbell et al, NW SW SW 36-7n-14w, south of Carnegie, Kiowa County, Oklahoma. The test was starting last week, and it will go to the Wilcox sand or 2,000 ft.

DELTA Drilling Co. 1 Gentry, in the C. M. Walters Survey, Henderson County, Texas, was drilling below 8,400 ft. in shale and lime.

VIRGINIA Drilling Co. 1 Estey, wildcat in SW NE 25-21-11w, Stafford County, Kansas, set surface pipe at 210 ft. and was ready to drill ahead.

PRINCE BROTHERS, Electra, Tex., were slated to resume drilling at J. B. Stoddard's scheduled Smackover lime exploration a mile west of Alma in southeastern Ellis County, Texas. The well, 1 E. E. Smith, was spudded last week end and surface casing set at 280 ft. for the 6,500-ft. hole.

BRYAN Petroleum Co. has the contract and was drilling below 1,203 ft. on the Burns Oil Co. 1-A Kinch, a wildcat in NW SW SE 18-3s-10e, near Boggy Depot, in Atoka County, Oklahoma, after setting the 12½-in. pipe at 1,015 ft.

NOBLE Drilling Co. has the contract for Pure Oil Co. 1 Cox, SE SW SE 16-5n-8e, Cimarron County, Oklahoma. Contract depth is 8,000 ft. This Ordovician exploration is on a block of 60,000 acres assembled by Pure over 2 years ago.

H. M. WILLIAMS, Wichita, Kans., drilling contractor, last week spudded a test being drilled for Joe A. Aylward and Aylward Production Co., C N¼ NE NE 34-29s-2w, Sedgwick County, Kansas.

FALCON-SEABOARD Drilling Co. et al 1 Altand, NW NE NE 31-25-8w, Reno County, Kansas, was drilling below 3,800 ft.

TAUBERT & McKEE, drilling contractors of Fort Worth, Tex., have been awarded contract to drill a Mississippian test for Gulf Oil Corp. on its block of approximately 3,000 acres astride the Clay-Jack County, Texas, lines. The test will be drilled in the southeast corner of the H. B. Bowen tract in Block 2641, T.E.&L. Survey. The location is west of the L. T. Burns 1 Tom Watson, dry hole drilled in Section 2639, T.E.&L. Survey, to the Ellenburger at 5,151 ft.

UNGREN & FRAZIER, drilling contractors, were rigging up for W. W. Wise and Merry Brothers 1 W. L. Butler, a northeast outpost for the Wimberly pool, in southeastern Jones County, Texas.

GRACE Drilling Co. has moved in and will start drilling a 6,000-ft. test on a lease of approximately 1,500 acres centering around the J. W. Maddox land about 9 miles northeast of Henrietta, Montague County, Texas. Roy Lee, trustee, has made location 330 ft. from the east and 330 ft. from the south lines of west 125, of north 250 acres, out of the T. M. Hughes Survey, Abstract 179, and about 1,000 ft. north of Shell Oil Co., Inc.'s 1 Maddox test which was drilled more than a year ago but lost the hole and was abandoned at a depth of 5,700 ft.

TRAUGH Drilling Co., Oklahoma City, Okla., is scheduled to immediately start 1 School Land, SW SE NE 16-6n-5e, north of the Grayson area, Pottawatomie County, Oklahoma.

RHODES Drilling Co. was running 7-in. casing in the Anderson-Prichard 2 Coker in the Novice pool of Coleman County, Texas, after an oil show in the Morris sand at 3,047 ft. Location is 330 ft. out of the SW cor. Section 72, G. H. Survey.

DANCIGER Oil & Refineries, Inc., has made application to drill its 2 A. J. Canon in the Stith pool, Jones County, Texas. Contract depth is 2,450 ft.

BREWSTER-BARTLE Drilling Co., Houston, Tex., has spudded in a Wilcox wildcat test for Adams Oil & Gas Co. in De Witt County, Texas. The location is 2 miles northeast of the nearest gas well. It also has started drilling 2 Account 2 for Ohio Oil Co. in the North Bay City field, Matagorda County, Texas. It has strings of tools working on Broderick & Gordon 1-A Lobits, near Addicks, Tex., and Navarro Oil Co. 1 McKee unit in the Mauritz field of Jackson County, Texas. The latter is an outpost well.

HARRY L. EDWARDS Drilling Co., Houston, Tex., has the contract for a semiwildcat test for Cities Service near Blessing, Matagorda County, Texas. It plans to go to 9,000 ft.

FAIN Drilling Co., Houston, Tex., will drill a semiwildcat for J. S. Abercrombie Co. in the South Ganado pool of Jackson County, Texas. On its own account it will put down a flank well to the Big Hill dome in Matagorda County, Texas, going to 7,000 ft.

GILGER Drilling Co., Houston, Tex., has finished Grubb and Hawkins 2 Cass fee in the Kildare extension to the Rodessa field in Cass County, Texas, getting as good a

Contractors

well as 1 Cass fee, a wildcat to which it was an outpost. Gilger now is moving over to begin work on Grubb and Hawkins 2 Grogan in the same area. The company completed 1 Scott, in the Bethany field, Caddo Parish, Louisiana, as a dry hole for Roy L. Scott.

O. W. DYER, Houston, Tex., is rigging up for two new wells. One, for Tide Water, is 1 McDonald, in the Berry & Williams Survey, Old Ocean field, Matagorda County, Texas. It is an extension well and is to go to 11,000 ft. The other, for Gulf, is 4 Schlicher Thomas, Easton townsite, Evangeline Parish, Louisiana. Mr. Dyer has several other strings of tools running.

GOLDRUS Drilling Co., Houston, Tex., is drilling 4 Hodnett, in the Midway field, Arkansas, for its own account. Pay is expected at about 6,500 ft.

GOLDING-FARRIS Drilling Co., Houston, Tex., has two strings of tools running for Stanolind. One is on 17 Vandenburg & Hill, in the East Placedo field, Victoria County, Texas. It will go to 6,850 ft. The other, an offset to production in the Mayo field, Jackson County, Texas, is 1 McCrory & Westhoff, expected to go to 5,400 ft.

Contractors Eye Supreme Court Ruling on Work Week

CONTRACTORS THIS WEEK reviewed the Supreme Court decision in the Warren Bradshaw vs. Hall case which held drilling firms are engaged in interstate commerce, for a clue as to whether Executive Order 9240 also may apply to their labor relations. Executive Order 9240 calls for payment of double time for all work on the seventh consecutive day and, if held applicable to drilling contractors, will interrupt current tour schedules and intensify economic and manpower problems. The Bradshaw decision, issued by Justice Murphy, held that contractors are liable to provisions of the Wage-Hour Act because their work, "closely identified as it is with the business of oil production, cannot escape the impact of the act by a transparent claim of ignorance of the interstate character of the Texas oil industry."

As contractors for companies whose products are vital war materials, drilling firms interpret Executive Order 9240 to be applicable to their operations. However, at last week's annual meeting of the American Association of Oilwell Drilling Contractors in Tulsa, new officers and directors were instructed to seek a specific ruling. Contractors pointed out that manpower shortages practically preclude the possibility of employing additional crews to break the work week at 6-day intervals. Contractors will seek a ruling from the National Labor Board, arguing that delays in moving rigs of a week or more afford drilling crews offtime commensurate with periodic days of rest.

Pertinent paragraphs of Executive Order 9240 follow:

"No premium wage or extra compensation shall be paid to any employe in the United States, its territories or possessions, for work on Saturday or Sunday except where such work is performed by the employe on the sixth or seventh day worked in his regularly scheduled work week and as hereinafter provided.

"Where because of emergency conditions an employe is required to work for seven consecutive days in any regularly scheduled work week a premium wage of double-time compensation shall be paid for work on the seventh day.

"Where required by provisions of law or employment contracts, not more than time-and-one-half wage compensation shall be paid for work in excess of 8 hours in any day or 40 hours in any work week or for work performed on the sixth day worked in any regularly scheduled work week.

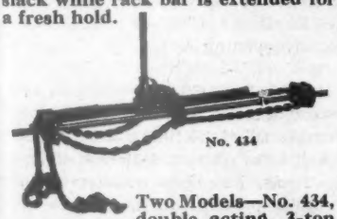
"No premium wage or extra compensation shall be paid for work on customary holidays except that time-and-one-half wage compensation shall be paid for work performed on any of the following holidays only: New Year's Day, Fourth of July, Labor Day, Thanksgiving and Christmas and either Memorial Day or one other such holiday of greater local importance."

Every concern with government war contracts or supplying such contractors is subject to regulations concerning rate of compensation in the president's order, it was ruled by an interpretation from the secretary of labor. The interpretation that war contracts are a factor in determining liability of employers for double time on the seventh consecutive day of work raises question among drilling firms whether their operations are directly related to war contracts.

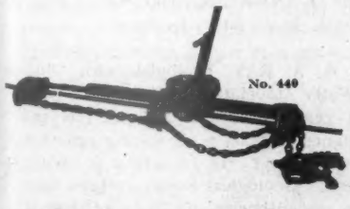
"Keep 'em Pumping"

Simplex Pull Rod Jacks

speed broken rod repairs on central power and back crank units, pulling the ends together in a straight line without kinking or damaging rods and so permitting "turtle-back" to be easily clamped on. Jack holds slack while rack bar is extended for a fresh hold.



Two Models—No. 434, double acting, 3-ton capacity, for shallow wells. Has 20½" travel with each "bite." No. 440, worm gear type, 7-ton capacity, for deep wells. Speed crank takes up rod line slack, lever bar used for actual pulling. Both jacks can be safely carried, set up and operated by a single operator, *saving manpower.*



Send for Bulletin Oil-42 describing these and other oil field jacks that are needed now more than ever to "Keep 'em Drilling and Pumping."

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Personal Paragraphs

HARRY L. WIRICK, independent operator of Tulsa, has been selected by Senator-elect E. H. MOORE, as his private secretary. Mr. Moore and Mr. Wirick have been associated in independent oil operations for many years at Okmulgee and Tulsa. Mr. Moore has announced that when he goes to Washington he will close his office and home in Tulsa, but would continue to operate his ranch properties at Okmulgee, Okla.

COL. T. H. BARTON, president of Lion Oil Refining Co., El Dorado, Ark., recently returned from a hunting trip in Colorado, on which he bagged two deer and an elk.

PARK J. JONES, formerly in Texas Co.'s petroleum engineering department in Fort Worth, Tex., has been transferred to the departmental manager's office in Houston, Tex.

WILLIAM NARRY, of Richfield Oil Corp., was master of ceremonies at the last monthly meeting of the California Transportation Club held at the Town House in Los Angeles.

EARL C. PERRY, one-time scout for Sinclair Prairie Oil Co., has just been promoted to the rank of captain in the Air Transport Command, and is now stationed somewhere in Africa.

DR. CHARLES W. RIPPIE, formerly petroleum technologist for the Solvay Sales Corp., has joined the petroleum chemicals department of Monsanto Chemical Co., St. Louis, Mo., where he will handle technical sales work.

J. B. REDDICK, of the technical supervisor's staff of Southern California Gas Co., discussed a "Method of Computing Gas Flow in Pipe Lines Using Reynold's Number," at the last meeting of the Southern California Meter Association held at the Rio Hondo Country Club, Los Angeles.

HARRY J. BAUER, president of Southern California Edison Co. which has productive properties in California fields, has been elected a director of the Friends of the Huntington Library, succeeding the late Frederick J. Williamson. The Huntington Library was founded by the late Henry Huntington and contains many fine works of art including the celebrated Blue Boy painting.

THEODORE GLEN FISHER has been commissioned a lieutenant, junior grade, in the Naval Reserve, and has reported to Tucson, Ariz., for indoctrination. Mr. Fisher has been employed by Cities Service Oil Co. for 9 years, having been geologist for the past 5 years at Odessa, Tex.

LAURENCE BRUNDALL, geologist with Shell Oil Co., Inc., and currently vice president of the East Texas Geological Society, has been commissioned an ensign in the aviation branch of the Naval Reserve. He is now awaiting orders.

WILLIAM H. CORREA

WILLIAM H. CORREA, general manager of the lubricating-oil department of Socony-Vacuum Oil Co., Inc., has been appointed head of the company's Washington office. Mr. Correa has been with Socony-Vacuum and its predecessor organization for some 35 years. He was a vice president of Standard Oil Co. of New York at the time of the merger with the Vacuum Oil Co. in 1933. H. STEWART MERRIMAN, from company's Lakes division operating out of Buffalo, has been appointed assistant general manager of the lubricating department. He will leave shortly for New York City to take over his office at 26 Broadway. GEORGE J. GREGOR, Buffalo district sales manager, has been appointed to fill vacancy created by Mr. Merriman's promotion.

LT. WILLIAM RANDALL, formerly in the production department of Signal Oil Co., Los Angeles, Calif., is now in Egupt, with the armed forces.

RALPH MARSHALL, vice president of Drilling & Exploration Co., Inc., has been elected national chairman of the topical committee on drilling practices, A.P.I.

D. O. BARRETT, chief engineer, Gulf Oil Corp., Tulsa, discussed "Engineering Bypasses War Shortages" before members and guests of the Engineers Club of Tulsa last Monday evening.

BYRON R. GOSSETT, who was assistant district superintendent for Humble Oil & Refining Co. in the Lovell Lake district, Jefferson County, Texas, has been transferred to a similar post in the Raccoon Bend district, Austin County, Texas.

J. E. PERKINS, Ponca City, Okla., has been elected president of the Natural Gas Accountants Association. W. J. McNALLY, Skiatook, Okla., is the new vice president, and E. J. NEWLIN, Oklahoma City, Okla., is secretary-treasurer.

B. A. RAY, geologist with Tide Water Associated Oil Co. for the past 4 years, at Midland, Tex., has resigned to start a consulting practice in Midland. He is active in West Texas Geological Society affairs and is an authority of the pre-Permian stratigraphy of West Texas.

REGINALD V. COGHLAN, former sales promotion manager of Ethyl Gasoline Corp., has been appointed assistant general sales manager by Beacon Chemical Corp., executive offices, Philadelphia, Pa. In conjunction with his other duties he will assume responsibility for the advertising and sales promotion of the company.

Do You Remember?

From The Oil and Gas Journal Files

40 YEARS AGO (1902)

The annual meeting of the Texas Co. was held November 24 in Beaumont, Tex. J. S. Cullinan was elected president; Arnold Schlaet, first vice president; R. E. Brooks, second vice president; Fred W. Freeman, secretary, and T. J. Donoghue, treasurer.

A well drilled near Winfield, Kans., which is over 2,000 ft. deep, bears the significant sign, "Opened by Mistake." The drillers were after coal, oil, or gas, and the sign board tells the whole story.

Never before have the prospects in the Kentucky and Tennessee oil fields been so bright as they are at present, and there is much in the situation to justify the assertion that the era of real development is beginning.

25 YEARS AGO (1917)

In the vicinity of Sapulpa, Okla., I.W.W. depredations have been threatened and guards are vigilantly watching oil properties. The guards will shoot to kill when there is reason for shooting, they declare.

Empire Pipe Line Co.'s oil line from Augusta, Kans., to Cushing, Okla., has been completed and is now carrying 22,000 bbl. a day.

Government lands in Shoshone Reservation, Maverick Springs, and Pilot Butte, Wyoming, have been disposed of and extensive drilling operations are contemplated by the purchasers. Among the latter is Carter Oil Co.

10 YEARS AGO (1932)

C. B. Ames, vice president, director, and member of the executive committee of the Texas Corp., was elected president of the American Petroleum Institute, at the thirteenth annual meeting of the Institute at Houston, Tex.

William G. Skelly, president of the International Petroleum Exposition, is calling a special meeting of the board of directors to consider the matter of holding an oil show in Tulsa during 1933.

H. S. Austin, chief superintendent of pipe-line construction for Iraq Petroleum, Ltd., and president of Ajax Pipe Line Co., has returned to London after having spent several weeks at Iraq.

GEORGE PASQUELLA, geologist-engineer, has been temporarily employed by the Interstate Oil Compact Commission to aid in making a survey of the stripper-well situation in the United States.

J. C. WALKER, Cities Service Oil Co., Bartlesville, Okla., will address the Oklahoma Minerals Industries Conference December 10, at Oklahoma City, Okla., on "Chemical Trends in the Petroleum Industry." B. W. LOGUE, chief chemist, Texas Co., Tulsa, will speak on "Oklahoma Oil-Field Brines and Their Utilization."

MILES SCULL, JR., editor of The Naturaluber, house organ of Lion Oil Refining Co., El Dorado, Ark., has resigned to become civil aeronautical instructor at Kenneth Starnes' Flying Service at Conroy, Ark. Mr. Scull, in addition to his position as house-organ editor, was also manager of the company's public-relations department.

JUDGE E. E. TOWNES, head of the legal department of Humble Oil & Refining Co., Houston, Tex., will be chairman of this year's newsboys' Christmas tree fund in Houston. The tree will be held the night of December 23, with some 1,200 children expected to participate in the distribution of clothing, food, and toys.

DAVID HARRIS, treasurer of Humble Oil & Refining Co., Houston, Tex., has been appointed as a member of the advisory committee to the regional director of the War Labor Board. The council will function in Texas, Oklahoma and Louisiana, and will rule on requests for wage increases for approximately 8 million workers in 29 major industries.

DR. CLAUDE E. ZOBELL, of Scripps Institute, La Jolla, Calif., was the speaker last Thursday before the Houston (Tex.) Geological Society at its weekly meeting. His subject, which had a direct bearing on petroleum geology, was "The Importance of Microorganisms as Geological Agents." Dr. Zobell is a director of A.P.I. Research Projects 43.

HARRY F. SINCLAIR, president of Consolidated Oil Corp., headed a party which inspected Sinclair Prairie Oil Co.'s pipe-line project from Corpus Christi to Damon Mound, in Brazoria County, Texas. The other members of the party, who met in Houston, Tex., and drove to Corpus Christi, were DANIEL T. PIERCE, assistant to Mr. Sinclair; E. W. SINCLAIR, president, Sinclair Refining Co.; NELSON K. MOODY, president, Sinclair Prairie Oil Marketing Co.; H. L. PHILLIPS, president, Sinclair Prairie Oil Co.; J. W. JORDAN, vice president and general superintendent, Sinclair Prairie Oil Co.; G. H. TABER, JR., vice president, Sinclair Refining Co.; H. A. KING, vice president, Sinclair Prairie Oil Co.; C. E. CHRISTIE, head of the pipe-line department of Sinclair Prairie Oil Co. and in charge of building the new line; E. Z. HANNON, head of the land department of the company.

ELMER JARRETT and WILLIAM CALDWELL, of the production department of Kendall Refining Co., Bradford, Pa., were honored at a dinner in Bradford last week, which was highlighted by presentation of National Safety Council awards. Presentation of the awards was made by J. B. FISHER, executive vice president of Kendall.

GORDON L. FARNED, superintendent of the Baytown, Tex., refinery of Humble Oil & Refining Co., has announced that the company will provide a 10-acre site for the Tri-Cities Hospital projected by Goose Creek, Pelly, and Baytown. An executive committee composed of officials of the three municipalities is to work out details of the enterprise.

Heads Jersey Board

Ralph W. Gallagher, elected this week chairman of the board of Standard Oil Co. of New Jersey, succeeding Walter C. Teagle, reached this high office through a series of steady advancements from the ranks. He became a member of the company's board in 1933, when he was appointed to supervise the company's natural-gas interests. His appointment this week comes as one of several changes involving top executives of Standard of New Jersey, which are reported elsewhere in this issue.

RALPH W. GALLAGHER

Mr. Gallagher's business life started before the turn of the century, when in 1896 he went to work in Olean, N. Y., for New York Transit Co. He had a high-sounding title, that of assistant engineer, but he chuckingly admits that the duties were anything but lofty, being more of the order of menial odd jobs. However, during the ensuing 4 years, he advanced by successive stages to more important and interesting jobs—oiler, tank gager, and field roustabout for New York Transit, National Transit, and United Pipe Lines.

He was transferred, then, to Akron, Ohio, as shop foreman for East Ohio Gas Co., and later to Canton, Ohio, to help build a parallel line the company was laying from the Ohio River to Akron. Later he acted as general foreman and paymaster when the gas lines were extended to Cleveland in 1902, and became superintendent of main lines outside of Cleveland, and in 1908 was made superintendent of the system. His next post was that of general superintendent of all city plants and main lines of the company, after which he became a director. It was not long before he was promoted to manager and vice president, and in 1926, when M. B. Daly, president of the system, died, Mr. Gallagher was named to succeed him. He occupied this position until 1933, when he was called to New York.

TRUMAN P. MOOTE, who has been with J. S. Bache & Co. for the past 9 years, will shortly join the staff of Coralena Oil Co., Tulsa. The Coralena company, headed by ALBERT H. KASISHKE, is active in western Kansas, and also operates in Oklahoma.

NORTH BIGBEE, recently public-relations manager of Texas Mid-Continent Oil and Gas Association, at Dallas, is now an Army lieutenant and newly started on his duties as public-relations officer, Army Air Forces Flexible Gunnery School, at Tyndall Field, Panama City, Fla.

JULIUS E. EAVES, for the past 8 years supervisor of truck operations at Albuquerque, N. M., for Magnolia Petroleum Co., has been made district manager of the Albuquerque district office of the Office of Defense Transportation.

FORREST J. BURROUGHS, JR., formerly production foreman for Shell Oil Co., Inc., on the Richie lease in Kilgore, Tex., is now an aviation cadet. He was stationed at Nashville, Tenn., but expected to be moved soon.

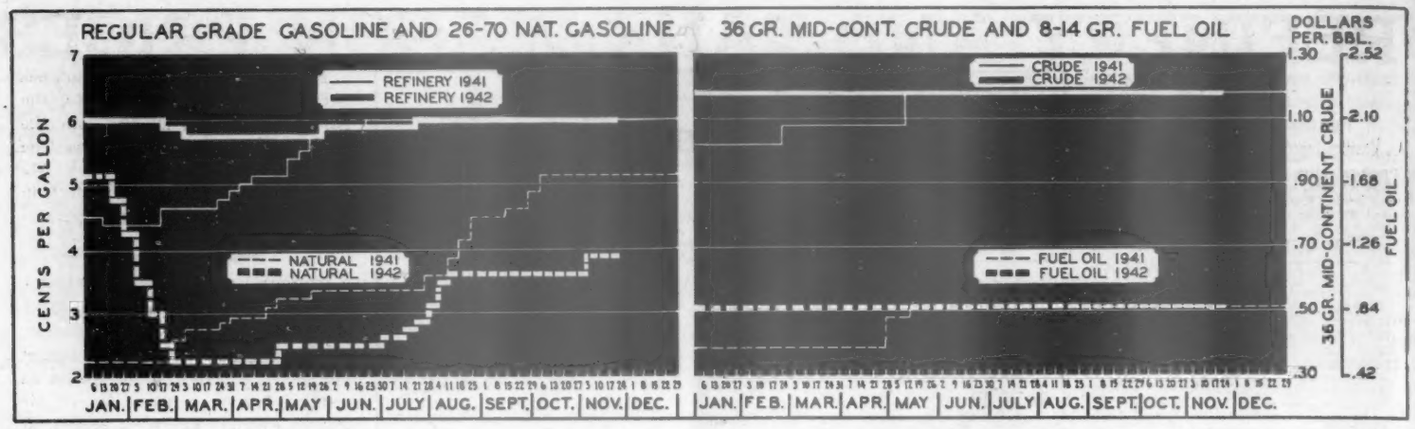
E. C. SEYMOUR, controller of Magnolia Petroleum Co., Dallas, Tex., has been elected to membership in the Controllers Institute of America, a technical and professional organization of controllers devoted to improvement of controllership procedure.

SAM D. W. LOW, JR., who spent 5 years in the oil business in Mexico and Venezuela, and later an attorney in Houston, Tex., has been appointed to the Latin-American staff of the Board of Economic Warfare, of which Vice President Wallace is head.

L. C. DECIUS, Tide Water Associated Oil Co., has been appointed a member of the subcommittee on joint use of facilities for the production division of the oil industry in District 5, the purpose of which is to work out means by which both material and manpower can be conserved by the oil industry.

J. P. COLEMAN, oil operator of Wichita Falls, Tex., was in Washington, D. C., this week where he appeared before the Lea congressional committee at an oil hearing. He represented the North Texas Oil and Gas Association which cooperated with the Independent Petroleum Association of America in presenting testimony regarding the crude-price structure.

Shifts: OWEN B. WOOD, geologist, Atlantic Refining Co., Corpus Christi, to San Antonio, Tex.; J. B. LOYD, engineer, Texas Co., Minot to Bismarck, N. D.; LEO RANNEY, president, Ranney Oil Mining Co., Columbus, Ohio, to Franklin, Pa.; W. F. PALMER, president, Palmer & Chenault, Inc., Wichita Falls to Houston, Tex.; FRANK B. CUTTING, superintendent, Humble Oil & Refining Co., Jennings, La., to Los Angeles, Calif.



MARKET DEVELOPMENTS . . .

East Coast

NEW YORK.—With prospects of shipments into District 1 substantially reduced, more stringent controls over consumption are expected to follow last week's reduction from 4 to 3 gal. in the basic gasoline-ration unit. These controls are not expected to be limited to the present scrutiny of motor-fuel consumption by holders of other than A cards, but are likely to be extended to fuel oil where a system of priorities may be installed. Under the suggested system, consumers of fuel oil would be registered with respect to the essential character of their needs and those found to be more essential, such as defense industries, would get first call on available supplies.

The discrepancy in shipments is attributed almost entirely to the failure of tank-car shipments to equal expectation. Though reports for the week ended November 14 indicate a slight degree of improvement, tank-car shipments are still more than 150,000 bbl. per day short of anticipations. It is generally conceded now that the level of 950,000 bbl. per day for November will not be reached.

The only alternative to more severe rationing is an increase in coastwise tanker shipments and this possibility is becoming increasingly remote as the scope of United Nations naval and land operations expands. This is supplemented by the fact that supplies for the North African operations were taken from the East Coast. The reason for this, in view of large supplies available elsewhere, is that the tanker distance from New York to North Africa, for example, is approximately 1,500 miles less than from Gulf Coast ports.

Mid-Continent

BUYING pressure persisted this week on practically all refinery products. Motor fuel, less than a week away from nation-wide curtailment via mileage rationing, was ordered out at approximately unchanged volume by contract customers. Consumption of automotive fuel has been maintained at contraseasonal levels in some sections because of the "last fling" impulse among numerous drivers. A more reliable barometer on gasoline demand for long-term considerations, however, is the continued call from distributors in agricultural and defense-plant areas.

Provisions of the mileage-ration regulations show that agricultural machinery and defense transportation facilities will receive the most liberal consideration as essential activities. Consequently, refiners are attempting to solidify their marketing positions in rural and defense areas for the long-pull consumption.

Deferment of the increase in railroad-freight rates for at least 6 months, ordered last week by the Interstate Commerce Commission, gives Mid-Continent refiners a "breathing spell" in which to impress OPA with the necessity of adjusting ceiling prices in conformance with costs.

Prices for all products this week continued unchanged. Demand was particularly brisk for kerosene and all other grades of distillate fuel. Railroads and war industries in the southwestern and midwestern states are calling for additional supplies of residual fuel oil but Mid-Continent plants, as a general rule, are unable to bid for the additional business.

SENTENCE SUMMARIES

MID-CONTINENT: Demand for all products sustained. Suppliers rejecting potential business on many grades of fuel oil.

EAST COAST: Priority distribution of fuel oil in prospect. Overland deliveries lagging behind expectations.

GULF COAST: Refiners pressed to meet current and future-indicated requirements for all grades of light fuel oil. Prices steady, unchanged.

PACIFIC COAST: Natural-gasoline market tone improved. Finished motor-fuel movement featureless, at low of quoted range.

PENNSYLVANIA: Bright stocks and fuel oils in active demand. Prices on all products steady, mostly at ceilings established by OPA.

A.P.I. REFINERY REPORT

Week Ended November 14, 1942

(Figures in thousands of barrels)

	Dly. crude runs to stills	Stocks Gasoline	Residual	Gas oil
Appalachian	165	2,567	433	784
Ind., Ill., Ky.	770	13,798	2,713	6,359
Okla., Kans., Mo.	357	6,042	1,404	2,102
Censored group*	1,686	38,586	16,327	27,207
Rockies	89	1,582	583	423
California	721	16,843	55,171	12,986
Total Nov. 14, 1942	3,788	79,418	76,631	49,861
Total Nov. 7, 1942	3,874	79,238	79,125	49,034
Total Nov. 15, 1941	4,054	83,683	94,972	56,380

Note: Refinery runs and stocks for week ended November 21, 1942, appear on Trends page.

*Report combined on East Coast, Texas Gulf, Louisiana-Arkansas and Inland Texas at request of OPC.

CRUDE-OIL STOCKS

(Bureau of Mines Estimate)

Week ended:	Bbl. of crude*
November 14, 1942	235,262,000
November 7, 1942	236,198,000
November 15, 1941	240,399,000

*Excludes heavy, unrefinable stocks in California.

Gulf Coast

HOUSTON, Tex.—Intensified scarcity of transportation facilities added to the problems facing oil refiners and marketers of the Gulf Coast area this week. "About the only way you can move gasoline now is in a bucket," declared one harried marketer, who said he was almost 30 days behind in his deliveries and was suffering cancellation of orders because of his inability to fill them within a reasonable time. The situation with regard to other oil products is not quite so embarrassing, largely for the reason that sellers were more careful about assuring themselves of means of moving the material. Refiners and marketers lucky enough to have tank cars at their disposal can find buyers for every gallon of motor fuel in their tanks, notwithstanding the fact that the trade now is entering a season when demand ordinarily fails to keep even with supply.

Tightening of the natural-gasoline market, apparent for several weeks, is becoming more pronounced. Marketers say that even when they find stocks of this material available they could only handle it at a loss because of transportation costs, so they are maintaining a handsoff position.

Tightness which has marked the fuel oils for weeks seemed intensified. Buyers were combing the district in effort to find supplies. "If they think you've got any fuel oil they'll wring your arm off trying to get it," asserted a supplier, referring particularly to importunate demand in the North and East. Kerosene is hard to get, and some marketers are not quoting. Gas oils were plentiful enough, but later drafts on stocks would keep them from becoming burdensome, it was reported.

Pacific Coast

LOS ANGELES, Calif.—The natural-gasoline market strengthened this week, reacting to cooler weather and demand for greater volatility in automotive fuel. Most natural-gasoline supplies are covered by long-term contracts but the limited volume available for spot-market trading is reflecting a firmer price tone.

Clean, heavy crude oil in the Wilmington field is moving in the fuel-oil market, indicating the strength of residual burning materials. Buyers are paying 5 cents per barrel more for Wilmington heavy crude for fuel purposes than the pegged quotation on residuals.

Top prices are being quoted and offered for light fuel oils. Kerosene is particularly active in the fruit-growing areas where it will be used extensively in combating frost. Supplies are limited. Refiners are willing to stock light fuels with the prospect that they will be required in larger volume later in synthetic-rubber and aviation-gasoline production.

REFINERY AND TANK-WAGON PRICES

(Prices as of November 24)

Quotations are f.o.b. plant in cars and in cents per gallon except where otherwise noted. They are exclusive of the federal excise taxes of 1.5 cents a gallon on gasoline and 4.5 cents a gallon lubricating oils, and do not include marine lighterage charges.

Refinery Gasoline

Octane (A.S.T.M.):	†80	78	74-76	72-74	68-70	63-66	60 & lower
Mid-Continent*	.....	.....	.....	5.875-6.000	.....	5.500-5.625	5.125-5.250
Pennsylvania	.....	.....	6.750-7.000	.....	.....	.....	.....
Gulf Coast‡	6.00-6.50	.....	.....	§5.750-6.250	§5.750-6.250	§5.250-5.750	§5.000-5.500
Northeast Coast	9.80	.....	.....	9.2	9.2	.....	.....
Pacific Coast	.....	6.500-7.000	6.250-6.500	6.125-6.250	5.750-6.000	5.125-5.250	4.750-5.000

*Basis Group 3. †1939 C.F.R. (research method). ‡Integrated companies restricted to lowest prices. §Unleaded.

Natural Gasoline

Grades:	26-70	18-55	75-85(350-375)
Oklahoma (Group 3)	3.875	4.650	.....
North Texas	3.500	4.200	.....
North Louisiana	3.625	4.350	.....
California	.....	.....	4.875-5.500

Kerosene and No. 1 Fuel Oil

Gravity:	46	45	42-44	41-43	38-40
Mid-Continent*	.....	.....	4.500	4.375	.....
North Louisiana	.....	.....	.....	4.500-4.750	.....
Pennsylvania	6.250-6.625	6.125-6.250	.....	.....	.....
California	.....	.....	.....	4.500-5.500	4.250
Northeast Coast	.....	.....	.....	6.80	.....
Gulf Coast	.....	.....	.....	3.875	.....

*Basis Oklahoma Group 3.

Tractor, Diesel, and Bunker Fuel Oil

Specifications:	46-48° G.	24 D.I.	48-52 D.I.	58 & above	Diesel bunkers	Bunker C
Mid-Continent*	4.125	.....	.....	.....	.....	.....
California	.....	2.750-4.000	.....	.....	‡$1.35-1.45	$0.85-0.90
Gulf Coast	.....	.....	4.000	4.125	1.45	0.85
Northeast Coast	.....	.....	.....	6.800	2.780	1.65
North Louisiana	.....	.....	.....	.....	.....	†0.80-0.85

*Basis Oklahoma Group 3. †10-14° gravity. ‡Pacific Specification 200.

Furnace Oil, Gas Oil, Fuel Oil

	No. 2	No. 3	No. 5	No. 6
Mid-Continent*	3.625-3.750	3.500-3.625	$0.85	$0.80
Pennsylvania (West)	5.875-6.125	5.875-6.000	†5.250-5.500	.....
Northeast Coast	6.7	6.7	1.95	1.65
Pacific Coast	5.5	5.5	‡0.80-95	§0.80
Gulf Coast	3.875-40	.....	1.65	0.85

*Basis Oklahoma Group 3. †36-40 gravity fuel oil. ‡Pacific Specification 300. §Pacific Specification 400.

Lubricating Oils

Bright and Steam Refined

OKLAHOMA (Group 3)—		
200-210 D, 10-25		27.00
150-160 D, 0-10		23.00
120-125 D, 0-10		22.00
Steam refined:		
600 dark green (untreated)	9.00	9.50
PENNSYLVANIA—		
Bright Stocks (Pennsylvania Grade No. 8 color, 140-150 at 210, 545-550 flash):		
10 pour point		30.50
15 pour point		29.50
25 pour point	25.00	28.00
Steam refined:		
600	15.00	16.00
650	15.50	16.50
600 flash	16.00	17.50
630 flash	17.00	17.50

Neutral Oil

(Vis. at 100° F. except Pennsylvania and color N.G.A.)

OKLAHOMA (Group 3)—	
0-10 pour point:	
200-3	15.00
300-3	18.00
500-3	19.50
600-3	20.00

Note: Viscous neutrals, 10-25 pour, quoted 0.5 cent under 0-10 oils.

Wax

(Cents per pound)

OKLAHOMA (Group 3)—	
124-126 (A.m.p.) w.c. scale	4.250
PENNSYLVANIA (Inland refineries)—	
122-124 (A.m.p.) w.c. scale	4.250
124-126 (A.m.p.) w.c. scale	4.250

Neutral Oil

CALIFORNIA—		
Pale oils:		
200-2½-3	7.00	7.75
400-3-4	7.25	8.00
600-3-4	8.75	11.00
Red oils:		
200-4-5	7.00	7.75
400-5-6	9.00	11.00
500-900, 5-6½	9.25	11.25
GULF COAST—		
Pale oils:		
200-3	8.50	8.75
300-3	9.00	9.25
500-3½	9.75	10.00
750-3½	10.00	10.25
2,000-4	10.50	10.75
3,000-4	12.25	12.50
PENNSYLVANIA—		
150 vis. at 70° F., 3 color, 400-405 flash:		
Zero pour point		37.50
10 pour point		36.50
15 pour point		35.50
25 pour point		30.00
200 vis. at 70° F., 3 color:		
Zero pour point		39.50
10 pour point		38.50
15 pour point		37.50
25 pour point		32.00
NEW YORK—		
Wax in bags fully refined:		
130-132 (A.m.p.) wax		5.850
133-135 (A.m.p.) wax		6.150
Crude scale:		
124-126 (A.m.p.) w.s.		4.250
124-126 (A.m.p.) y.s.		4.250

EXPORT PRICES

Gasoline—60-62° Gravity, Maximum 400 End Point

Octane:	72-74	68-70	65-66	60
Gulf Coast	6.050	6.250-6.500	5.875	5.625
Pacific Coast	.....	6.125-6.500	5.875-6.000	5.500-5.625

Distillate and Fuel Oil

	Kerosene	Diesel fuel				Bunker
	41-43	24 G.	48-52 D.I.	58 D.I.	Bunkers	C grade
Gulf Coast	4.000-4.250	.....	4.125-4.375	4.375	$1.65-80	$0.85-95
Pacific Coast	4.750-5.000	1.25-30	.....	.....	†1.35-45	*0.80-85

*Pacific Specification 400. †Pacific Specification 200.

Lubricating Oils

	Neutral oils		Bright and cylinder stocks		
	200-3	150-3	200-3	150-3	600&630 S.R.
Mid-Continent	16.8	.....	28.8	24.8	.....
Pennsylvania	43-50	41-46	36-37	36-37	26.5-27

GASOLINE AND KEROSENE TANK-WAGON PRICES IN 50 CITIES

(Gasoline prices based on regular grades, tax included, undivided dealer)

ATLANTIC AND NEW ENGLAND

(Socony-Vacuum Oil Co., Inc., and Atlantic Refining Co.)

	Dealer tank wagon	Combined tax	Kero. tank wag.
Baltimore, Md.	15.45	5.50	10.20
Boston, Mass.	14.90	4.50	9.50
Burlington, Vt.	16.90	5.50	.....
Buffalo, N. Y.	16.20	5.50	10.30
Dover, Del.	16.70	5.50	11.20
Hartford, Conn.	15.60	4.50	.....
Manchester, N. H.	17.30	5.50	10.50
Newark, N. J.	14.70	4.50	9.40
New York, N. Y.	16.10	5.50	9.50
Philadelphia, Pa.	16.20	5.50	11.65
Pittsburgh, Pa.	16.70	5.50	12.00
Portland, Me.	16.30	5.50	9.60
Providence, R. I.	15.00	4.50	9.30
Washington, D. C.	14.70	3.50	10.70
Average 14 cities	15.91	5.07	10.32

(All prices undivided dealer basis.)

CENTRAL

(Standard Oil Co. of Indiana, Standard Oil Co. of Ohio, Continental Oil Co. and Texas Co.)

	Dealer tank wagon	Combined tax	Kero. tank wag.
Chicago, Ill.	13.40	4.50	10.30
Cleveland, Ohio	15.00	5.50	*9.00
Dallas, Tex.	13.00	5.50	7.09
Des Moines, Iowa	14.40	4.50	9.80
Detroit, Mich.	14.40	4.50	9.60
Fargo, N. D.	16.90	5.50	11.30
Huron, S. D.	16.30	5.50	10.70
Indianapolis, Ind.	15.20	5.50	9.80
Little Rock, Ark.	17.50	8.00	10.00
Milwaukee, Wis.	16.10	5.50	10.50
Minneapolis, Minn.	15.40	5.50	10.30
Omaha, Neb.	15.40	6.50	9.80
Tulsa, Okla.	16.50	7.00	8.50
Wichita, Kans.	12.70	4.50	8.00
Average 14 cities	15.15	5.57	9.61

*Includes 1-cent state tax.

SOUTHEASTERN

(Standard Oil Companies of New Jersey, Kentucky, and Louisiana)

	Dealer tank wagon	Combined tax	Kero. tank wag.
Atlanta, Ga.	21.40	7.50	11.40
Birmingham, Ala.	18.50	8.50	9.00
Charleston, S. C.	18.45	7.50	.....
Charleston, W. Va.	18.75	7.50	13.00
Charlotte, N. C.	19.60	7.50	11.00
Jacksonville, Fla.	21.40	8.50	10.40
Jackson, Miss.	17.50	7.50	8.50
Louisville, Ky.	16.50	6.50	8.50
Memphis, Tenn.	18.60	8.50	10.50
New Orleans, La.	16.75	8.50	*10.00
Norfolk, Va.	16.95	6.50	13.50
Average 11 cities	18.58	7.59	10.58

*Includes 1-cent state tax.

MIDWESTERN

(Continental Oil Co.)

	Dealer tank wagon	Combined tax	Kero. tank wag.
Albuquerque, N. M.	17.50	7.50	10.00
Boise, Idaho	20.10	6.50	16.50
Casper, Wyo.	17.00	5.50	12.00
Denver, Colo.	14.50	5.50	11.00
Helena, Mont.	17.00	6.50	13.00
Phoenix, Ariz.	18.50	6.50	12.50
Reno, Nev.	17.50	5.50	13.50
Salt Lake, Utah	18.50	6.50	14.50
Average 8 cities	17.58	6.25	12.88

PACIFIC COAST

(Standard Oil Co. of California)

	Dealer tank wagon	Combined tax	Kero. tank wag.
Portland, Ore.	17.00	6.50	13.50
San Francisco, Calif.	14.50	4.50	11.50
Seattle, Wash.	17.00	6.50	13.50
Average 3 cities	16.17	5.83	12.83
Average 50 cities	16.57	5.96	10.76
Average last week	16.57	5.96	10.76

Canadian Fields

(Continued from Page 178)

formation around 2,100 ft. but developed considerable salt water.

Saskatchewan Operations

In southern Saskatchewan, Northwest-Radville 1, LSD 16, 36-5-19w2, has resumed after a difficult fishing job, and is redrilling in the Madison limestone below 6,000 ft.

In the Kamsack field, eastern Saskatchewan, Colgate 22, NW and Colgate 23, NE LSD 14, 23-29-32w1, have finished as good shallow gassers. Production will be utilized by Kamsack Gas & Oil Co. Northern Royalties 3, LSD 6, 35-29-32w1, passed through hard limestone at 1,719 ft. into soft brown limestone with some oil and gas, and is running casing for production test.

Ontario Shallow Crude

In the old Dutton shallow field, in Elgin County, Ontario, Empire Oil Royalties has made its first shipment of crude. The field is in Dunwich Township, about 20 miles west of St. Thomas, and was first opened about the year 1896. The Empire company recently took over some 59 abandoned wells, which at one time had a fair pumping production from the Onondaga formation around 450 ft. These wells are being cleaned out and reconditioned. So far, seven wells have been reamed, cleaned and recased and pumps installed. A central pumping unit will be set up and as soon as it is put in operation regular shipments will be made.

CRUDE-OIL PRICES

Representative selected crude prices from all sections of the country appear below:

East Texas	$1.25
Conroe	1.43
Tepetate, Louisiana	1.18
Illinois basin	1.37
Pecos County, Texas	.95
Bradford, Pennsylvania	3.00
Van, Van Zandt County, Texas*	1.08

*No change since 5-21-41.

Gravity Schedules

Top prices include all gravities above grades designated, and low prices include all gravities below grades designated:

Gravity	Signal Hill, Calif.	Oklahoma, Kansas	Gulf Coast Texas	West Texas*
18-18.9	$0.80	.....	.....	.....
19-19.9	.84	.....	$1.06	$0.70
20-20.9	.88	$0.85	1.08	.72
21-21.9	.92	.87	1.10	.74
22-22.9	.96	.89	1.12	.76
23-23.9	1.00	.91	1.14	.78
24-24.9	1.03	.93	1.16	.80
25-25.9	1.07	.95	1.18	.82
26-26.9	1.11	.97	1.20	.84
27-27.9	1.15	.99	1.22	.86
28-28.9	1.18	1.01	1.24	.88
29-29.9	1.20	1.03	1.26	.90
30-30.9	1.23	1.05	1.28	.92
31-31.9	.....	1.07	1.30	.94
32-32.9	.....	1.09	1.32	.96
33-33.9	.....	1.11	1.34	.98
34-34.9	.....	1.13	1.36	1.00
35-35.9	.....	1.15	1.38	1.02
36-36.9	.....	1.17	1.40	1.04
37-37.9	.....	1.19	1.42	1.06
38-38.9	.....	1.21	1.44	1.08
39-39.9	.....	1.23	1.46	1.10
40 and above	.....	1.25	1.48	1.12

*Includes Lea County, New Mexico.

EQUIPMENT PROGRESS...

New Improved AC Welding Machine

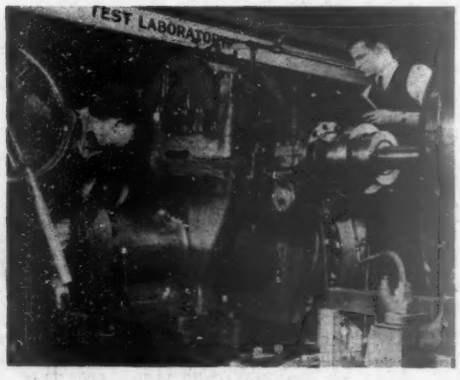
A new a.c. transformer-type welding machine that combines exceptional safety with improved operating efficiency is announced by Wilson Welder & Metals Co., Inc., 60 East Forty-second Street, New York. The most interesting feature of the new Wilson "Bumble Bee" a.c. welder is its low open circuit voltage of 42 volts, automatically and positively maintained by means of recent Wilson engineering developments.

Two primary coils are used instead of the usual one, with a magnetic contactor in the circuit of one primary. Each primary contributes approximately 42 volts to the total open-circuit voltage, which is actually 84 to 85 volts. However, when the machine is idle one primary is automatically cut out, restricting the open-circuit value to 42 volts. As soon as the electrode contacts the work the second primary is thrown into the circuit, and if there were not a dead short, the voltage would be 84-85 volts.

When the operator draws an arc, this open-circuit potential of 84-85 volts enables him to establish his arc quickly and begin welding. Most welding operations are performed at between 32 and 40 volts. When welding is completed and the operator pulls out or lengthens his arc, the arc voltage rises. The moment it reaches 45 volts, the contactor opens and cuts out one primary, leaving only 42 volts in the open circuit.

Pump for "Big Inch" Line

On test at the Allis-Chamers Manufacturing Co. plant in Milwaukee, Wis., is the first pump ready for



the "big inch" pipe line. The special pump is one of 20 being rushed to completion for War Emergency Pipelines, Inc.

Motor Finder Aids in Proper Selection

To help motor users fill their wartime motor needs with the least possible delay, as well as conform to recent WPB recommendations, Allis-Chalmers, Milwaukee, Wis., now offers a new "motor finder" for quickly selecting the various types of squirrel-cage motors.

With the new Motor Finder slide rule, the motor user is able to match the conditions under which the motor must operate at the proposed installation with the required motor characteristics and instantly learn the right motor type and is features. Only three simple steps are necessary to pick a motor. Since over 30 standard types, covering a range in horsepower from ½ to 75, are included in the Allis-Chalmers Lo-Maintenance line, all of the characteristics of versatility of squirrel-cage motors are immediately considered in using the slide rule. The potential motor buyer thus takes fullest advantage of the most available motors he can buy in wartime.

Copies of the new slide rule can be obtained free of charge on request.

Woobank Opens Houston Office

Woobank Pump & Machinery Co. announce opening of an office in Houston, Tex., in the Kress Building, to provide more active representation of the products they handle—principally Cook's Graphitic Iron piston rings and metallic rod packings. The office will be in charge of F. Black, who previously made his headquarters at Fort Worth, Tex.

Asphalt Flooring Laid Over Wood Base

With structural steel on the critical list, the problem of finding satisfactory alternates is not always a difficult job. Frequently other materials are available that have definite advantages.

A product of this type, known as Elastite industrial flooring, has advantages of hardness, toughness and density resulting in remarkable resistance to wear and abuse; ability to withstand moving loads of great intensity; resiliency that makes it comfortable under foot, less tiring to workers; nonskid surface that lessens accidents; resistance to fire and moisture; dustless surface which is necessary in so many industries; reasonable cost; low maintenance. The product is manufactured by Philip Carey Manufacturing Co., Lockland, Cincinnati, Ohio.

Motion-Picture Lessons In Grinding

A new series of motion pictures entitled "Lessons in Grinding" is now available from the Norton Co., Worchester, Mass., to industrial apprentice schools, Army and Navy training schools, all other classes where machine-shop practice is being taught, and to colleges, universities and vocational-training schools. The first film is on cutter sharpening, the second on the cylindrical grinder, the third on the surface grinder, and the fourth on the grinding wheel and its use and care.

New Hack Saw Frame

All loose blade studs and threaded tension devices have been completely eliminated in a new type of hack saw frame just introduced by Victor Saw Works, Inc., Middletown, N. Y., manufacturer of Victor hack saw blades. Blades are released or set up by a simple cam-action lever lock, in a fraction of the time required with the usual types of frames.

Made of heat-treated spring steel, this Victor frame is far more rigid than any other adjustable frame, permitting extremely high blade tension, which results in straighter cuts and fewer broken blades. Gunmetal finish affords high resistance to rust, perspiration and other forms of corrosion.

The frame is available with either pistol grip (Victor No. 20) or straight handle (Victor No. 30). Both handles are of patented design, molded of heat-resistant tenite—a nonconductor of electricity.

Blade can be repositioned to face in any of four directions, depending upon which of two sets of fixed pins it is laid over. To adjust length for either 8-in., 10-in. or 12-in. blades, operator merely pulls out pivot pin to open position, slides frame forearm in or out to desired length, and snaps pivot pin back into place.

There are no loose parts which can fall off accidentally. The frame will not jackknife with blade removed.

TRADE LITERATURE

JAMES F. LINCOLN ARC WELDING FOUNDATION, Cleveland, Ohio.—Large sheet, measuring 34 in. by 29 in., listing the winners of the awards in the $200,000 scientific welding study sponsored by the foundation. Capt. C. A. Trexel and A. Amirikian, director of planning and design, and design engineer, respectively, Bureau of Yards and Docks, Navy Department, Washington, were recipients of the $13,700 grand award in the nation-wide 2½-year program.

AMPION CORP., 4-88 Forty-seventh Avenue, Long Island City, N. Y.—Folder on Aquatone Fueltone Carbolite, and how it serves to counteract chemicals in boiler-feed water that cause scale and other troubles.

FOXBORO CO., Foxboro, Mass.—Catalog 95-A, describing the company's full line of instruments for the measurement and control of industrial process conditions. There are over 200 illustrations in the 48 pages of the catalog, which is the most comprehensive bulletin the company has ever prepared. The catalog is crossindexed, and this, plus ingenious use of colors, makes the catalog convenient and useful as a reference book on modern instrumentation.

MULTIPLE V-Belt Drive Association, 140 S. Dearborn Street, Chicago.—A 16-page pamphlet, "23 Ways to Conserve the Life of Your Multiple V-Belt Drives," prepared by the Engineering Research Bureau of the association. The book is a primer on the subject, written and illustrated in a simple, easy-to-understand style. It represents the association's contribution to the rubber-conservation movement, and its purpose is to help users to obtain maximum life from their V-belt drives.

BROWN INSTRUMENT CO., Philadelphia, Pa.—A 64-page booklet on "The Technique of Precision Control in Industrial Processes." It is intended to acquaint engineers, operators and management with the manifold applications of automatic control of industrial processes. The text is divided into chapters which feature precision measurement, fundamentals of control, types of controls, control valves and typical applications. It is profusely illustrated.

MICHEL-CATHER, INC., 2 Park Avenue, New York.—A new compact chart showing analyses, physical characteristics and applications of 19 different stainless steel, monel and nickel alloys. Also contains a handy crossreference of designations and type numbers of the Alloy Casting Institute, American Iron and Steel Institute and others. The chart is standard letter size.

CATERPILLAR TRACTOR CO., Peoria, Ill.—A 50-page book, entitled "Keep 'em Working," designed to aid owners of Caterpillar products in getting the most out of their machines. Illustrations include photographs and cartoons. The text supplements operator's instruction books, and goes into greater detail on the care of certain critical parts.

SKF INDUSTRIES, INC., Philadelphia, Pa.—A 32-page booklet, "A Guide to Better Bearing Lubrication," replete with designs, formulas and graphs which explain the highly technical text. Subjects treated include the functions of lubrication, oil lubrication, recommended viscosities, oil-supply systems, oil bath, circulating systems, spray or mist lubrication, wick feed, oil with compressed air, grease lubrication, how grease lubricates and other factors having to do with lubrication.

NORTON CO., Worcester, Mass.—A manual entitled, "What's Your Problem?—A Trouble-Shooting Manual for Grinding Machine Operators." A 28-page manual, this booklet should be useful to grinding machine operators, as it discusses improper and proper practices, and tells how the operator can get best results.

ALLIS-CHALMERS MFG. CO., Textrope Division, Milwaukee, Wis.—A 16-page booklet on "Plain Facts on Wartime Care of Rubber V-Belts." The booklet explains in what ways the anatomy of a V-belt affects

its maintenance; how bulging its muscle gives a V-belt its grasp; why a loose V-belt will stretch more in use than a tight one; a rule-of-thumb for measuring proper tension, and other important points in the care of this item.

MERCO NORDSTROM VALVE CO., 400 Lexington Ave., Pittsburgh, Pa.—A new refinery manual detailing the selection of specific valves for given applications, accompanied by recommendations regarding selection of metals or alloys and plug-valve lubricants. The manual lists all types of plug valves used in refineries, with sizes, pressures and method of operation. The manual is printed in color, on heavy enameled paper.

GRAVER TANK & MANUFACTURING CO., INC., East Chicago, Ind.—Bulletin Form 312, describing Graver chemical tanks and proportioning equipment. The bulletin is a four-page, illustrated piece.

CHAIN BELT CO., Milwaukee, Wis.—Folder describing the type of work Rex Speed Prime Pumps are doing in the fields, and some of the important features of these pumps. The pumps are made in capacities ranging from 3,000 to 125,000 g.p.h. All are portable and easily handled from rig to rig.

HAYNES STELLITE CO., Kokomo, Ind.—Bulletin, Stellite 98M2, entitled "Metal Cutting Tools for Machining Steel." The bulletin lists the sizes and prices of 84 standard square and rectangular tool bits, and of 74 varieties of welded-tip tools, all made of 98M2, the recently announced nonferrous cutting-tool material found successful for machining steel.

X-PANDO CORP., 43-15 Thirty-sixth Street, Long Island City, N. Y.—Folder outlining the merits of X-Pando pipe-joining compound. The compound is described as the only compound that expands as it sets. It is offered for use in ammonia, brine, oxygen, and freon lines and it said to work perfectly as a seal for all types of joints in all types of metal pipe. The manufacturer claims that the compound goes further and is less expensive than litharge and glycerin.

McKISSICK PRODUCTS CORP., Tulsa.—Catalog on blocks to fill the needs of practically every division of the petroleum industry. There are many illustrations of newly perfected blocks, designed for compactness, utility, safety and durability. By following approved specifications as to sheave design, blocks of greater utility and more satisfactory performance have been perfected in many classifications.

AMONG EQUIPMENT MEN...

Timken-Detroit Axle Co. Names Two Field Representatives

Guy Fiber of Detroit and L. E. Detrick of Chicago have been employed by Timken-Detroit Axle Co. as field representative to work with operators of motor vehicles, their mechanics and drivers in improving maintenance practices and driving habits.

Mr. Detrick, who will have headquarters at 2519 W. Winnemac Ave., Chicag Ill., will cover territory that includes Illinois, Wisconsin, Minnesota and Indiana. H. A. Mitchell was recently transferred from this territory to the West Coast.

Mr. Fiber will cover Michigan, Ohio, West Virginia and parts of Pennsylvania, with headquarters at 22422 Six Mile Road, Detroit.

Both Mr. Fiber and Mr. Detrick have had long experience in the automotive field. They will augment the large field force now conducting Timken's nationwide A.M. (Axle Maintenance) program, which includes the presentation of a sound-slide-film in color at prearranged meetings for the benefit of the personnel of operator organizations.

Cole Elected A.S.T.E. Director

Lester M. Cole, district manager for Warner & Swasey Co., at Houston, Tex., has been elected a director of the American Society of Tool Engineers from Region 17 for a 2-year term. Mr. Cole came to Warner & Swasey in 1925 as a tool designer and estimator. He has been manager of the company's Houston office since 1928. A.S.T.E. Region 17 comprises Houston chapter No. 29, North Texas chapter No. 51, and Wichita, Kans., chapter No. 52. Mr. Cole is past chairman of A.S.T.E. Houston chapter.

Gregory Vice President and Director of Thornton

Bruce Gregory, formerly in charge of sales of Thornton Tandem Co. of Detroit, Mich., has been made vice president in charge of sales and a member of the board of directors, according to an announcement made by A. F. Knobloch, president.

After his graduation from Michigan in 1926, where he was rated a star halfback, Mr. Gregory was with the sales department of Firestone Tire & Rubber Co. 2½ years. Following this he was with the General Tire Co. for over 9 years, occupying the position of central divisional sales manager. He has been associated with the Thornton Tandem Co. of Detroit, manufacturers of Four-Rear-Wheel Drive truck units, for about a year.

Twin Disc Clutch Co. Promotes J. B. Jenkins

Twin Disc Clutch Co., Racine, Wis., announces the appointment of John B. Jenkins as manager of the hydraulic division, Rockford, Ill.

For the last 8 years, Mr. Jenkins has been in charge of the company's factory branches at St. Louis, Mo., Tulsa, and Dallas, Tex.

Montrose Completes Eastern Trip

M. E. Montrose, vice president of Lane-Wells Co., has just returned to his office in Los Angeles, Calif., from a 7-week trip through the Mid-Continent and Gulf Coast areas and also through the East where he visited plants of some of the nation's leading machine-tool manufacturers.

Lane-Wells operations during the past year have been expanded to include the manufacture of specialized machine-tool accessories for the metal-working and oil-tool industries.

Westby Addresses Tulsa Nomads

Gerald H. Westby, president of Seismograph Service Corp., Tulsa, talked to the Tulsa Nomads at their monthly luncheon, October 26. He spoke on the subject, "The Petroleum Industry and the Civil Air Patrol." Mr. Westby is a captain in the Civil Air Patrol and in his talk outlined the objectives and war accomplishments of the corps as it has operated in the Southwest.

Three Dravo Corp. Engineers Win Prize Awards

Three engineers of the Dravo Corp., Neville Island, Pittsburgh, Pa., were awarded cash prizes in the recent industrial study sponsored by James F. Lincoln Arc Welding Foundation, Cleveland, Ohio. George F. Wolfe, chief plant engineer, was awarded $2,500 for his paper, "Large Sections of Hulls Prefabricated by Welding." C. Parry Streithof, structural divisions engineer, was awarded $1,750 for his paper on revolving gantry crane for shipbuilding, and R. M. Rush, manager, and H. A. Pietsch, of the industrial-machinery division, received $250 for a paper on design and development of a direct-fired unit heater for oil, gas and coal firing.

The James F. Lincoln Foundation for 2½ years has been carrying on its second industrial study on arc welding, for which 408 awards totaling $200,000 were announced last month.

Wm. J. Simpson Joins Engineering Staff of Milton Roy Pumps

"Bill" Simpson, a graduate engineer of Pennsylvania State College, and for several years design engineer for Baldwin Locomotive Works, Baldwin-Southwark Corp., and Brill Car Co., has joined the engineering staff of Milton Roy Pumps, Philadelphia, Pa., manufacturer of chemical, high-pressure and controlled-volume pumps.

His duties will be to cooperate with Milton Roy chemical, electrical and mechanical engineers in the development of special-purpose pumping equipment and, in particular, to help expedite manufacture of pumps required by rapidly expanding government programs for the production of chemicals, synthetic rubber and aviation gasoline.

Collins Heads Sales Policy of Elastic Stop Nut Corp.

William T. Hedlund, president of Elastic Stop Nut Corp., Union, N. J., has announced the appointment of Whitney C. Collins as vice president in charge of sales policy. Mr. Collins resides in Beverly Hills, Calif., and has been a director of the company since 1940.

In 1932 Mr. Collins formed Collins-Powell Co. of Beverly Hills, representing Elastic Stop Nut Corp. as sales engineers. He was instrumental in developing wide use of Elastic stop nuts in the aviation industry.

He was associated with Lockheed Aircraft Co. from 1928 to 1930, serving as a vice president, treasurer and general manager. He is a director of Menasco Manufacturing Co. and Radioplane Co.

Chain Belt Names Two

Chain Belt Co., Milwaukee, Wis., through J. C. Merwin, president, announces the appointment of George D. Gilbert as general manager of Baldwin-Duckworth. Baldwin-Duckworth, a division of Chain Belt Co., operates plants in Springfield and Worcester, Mass., manufacturing machine-finished roller chain and sprockets. Mr. Merwin also announces the appointment of William H. Gates as works manager of the Baldwin-Duckworth division.

Coe Heads New York Office Of Farrel-Birmingham

Farrel-Birmingham, Inc., Ansonia, Conn., and Buffalo, N. Y., announces the appointment of Edward S. Coe, Jr., as manager of its New York office at 79 Wall Street, to succeed E. H. Thomas, recently deceased.

Following 2 years at the Buffalo plant on gear sales, Mr. Poe spent a brief period at the New York office and then over a year as sales manager in the Chicago office. The next 3 years were spent at sales engineering at the company's main office in Ansonia. For the past few months he has been in charge of expediting production of Farrel-Sykes gear generating machines.

H. L. Watson Elected President Of De Laval Company

H. L. Watson, since 1934 executive vice president and director of De Laval Steam Turbine Co., Trenton, N. J., has been elected to the presidency of that company, succeeding Francis J. Arend, who died August 24, 1942. From 1913 to 1934, Mr. Watson was general sales manager. He graduated from Rose Polytechnic Institute, Terre Haute, Ind., in 1905 and served as erecting engineer and later as sales engineer, specializing in steam-turbine work, with Allis-Chalmers Co. until he entered the employ of the De Laval company,

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20 Years' Experience
Inquiries Invited

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FOR SALE: Oil and Gas Leases on proven structures, drilling propositions, small production and fluorspar deposits. Reports furnished. W. P. Harley, Bowling Green, Kentucky.

FOR SALE: Oil and gas leases North and South Dakota, ten cents acre. Owner, P. O. Box 1163, Tulsa, Oklahoma.

PARTIES to join me 400 acres leases and royalty, Picher, Oklahoma mining field, 4 shafts ready be equipped for zinc production. O. D. Baker, Miami, Okla.

Royalties

ANDREW J. BARRETT
The Philtower
Tulsa, Oklahoma.

WE BUY & SELL all types of Oil and Gas Royalties. Sales restricted to registered dealers only. Grimes Royalty Co., National Mutual Bldg., Tulsa, Okla.

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CAPITAL SEEKERS — Interested in raising $25,000 or more for a legitimate project should write to AMSTER LEONARD, Fox Theater Bldg., Detroit, Mich.

Oil Industry Printing

OIL FIELD LEGAL BLANKS
Leases, assignments, releases, township plat books, well records, etc. Request on your letterhead gets free catalog. Olds Press 215 East Third St., Tulsa, Okla.

Business Opportunities

WANTED: Reliable and capable oil operator to come in as a partner or to advance loan on large acreage in proven and active area of Jackson County, Texas. If interested, write to 602 Banker's Mtg. Bldg., Houston, Texas.

DRILLING Contractor contemplating a wildcat drilling campaign in shallow areas solicits associate who can afford to gamble two-fifty to five-hundred more or less. I consider it patriotic to wildcat at this time but it is highly speculative. If you are playing it safe, buy bonds. Don't waste mutual time. Box B-370, The Oil and Gas Journal, Tulsa, Okla.

Legal Blanks

THE BURKHART LINE of Legal Blanks Since 1908. Oil-Gas and Business Forms for Mid-Cont. and Illinois Basin. Leases Rev. with Gov.'s Regulations. Catalog and Samples. Burkhart Ptg. & Sta. Co., 115 So. Cincinnati, Tulsa, Okla.

Help Wanted

NOTICE TO ADVERTISERS

Advertisers offering positions to workers skilled in critical war industries are requested by the War Manpower Commission to include the following sentence in their advertisement:

"Applications from those now employed in war industries will not be considered."

ENGINEERS WANTED

Chemical or Mechanical with minimum one year oil refinery plant operation or maintenance experience. Require University Engineering School graduate with basic knowledge principles fluid flow. To work on process flow sheets, equipment selection and general handling oil refinery. Defense Contracts as assistant to senior engineers. No aliens or men engaged Defense work considered. Opportunity up to individual. In reply state experience, education, draft status, salary expected. Foster Wheeler Corporation, Room 2402, 165 Broadway, New York.

Situations Wanted

SEVEN years production, pipe line, lease, superintendent, and field representative, middle west fields. Twelve years highway-street construction, specializing asphalts. All positions of supervisory status. Best references. Services available December 1. Address Box B-362, The Oil and Gas Journal, Tulsa, Okla.

ENGINEER, college graduate, age 51, with 29 years ref. eng. experience, now and past 14 years superintendent, desires job in Texas plant. If interested, address Box B-372, The Oil and Gas Journal, Tulsa, Okla.

SALES AGENT AND MANAGER

With years of experience in large scale selling desires to market nationally a line of products. Free to travel the entire United States to sell direct or form agencies. Not subject to draft. Advise what you have to offer and terms. David Lutz, North Hills, Pa.

Incorporation

DELAWARE CHARTERS: Complete service $35. Submitted forms. Chas. G. Guyer, Inc., Wilmington, Delaware.

Equipment Wanted

DIESEL ENGINES

Total 1600 HP required, with or without Generators. Consider units 225 HP and larger. Also smaller high speed units for standby service. Preference given units immediately available. Give complete details and price. Address Purchasing Department, Box B-353, The Oil and Gas

Equipment Wanted

WANTED TO BUY

Pipe of all sizes, 2" to 16", inclusive, also refineries, pipe lines and abandoned wells. Wire, write or phone

Louisiana Iron & Supply Co.
Shreveport, La.

WANTED: Complete hydraulic casing pulling machine, preferably 400 ton capacity, to handle maximum of 16 inch casing. Box B-361, The Oil and Gas Journal, Tulsa, Okla.

WANTED

Abandoned *Pipe Lines*, in or out of the ground, *Oil Wells*, *Steel Buildings* and Steel Storage *Tanks* of all sizes.

JOS. GREENSPON'S SON PIPE CORP.
National Stock Yards, St. Clair Co., Illinois.

WANTED — Steel tanks total 120,000 gallon capacity. Will take 5000 gallon or larger. Tidewater Equipment & Machinery Corp., 305 Madison Ave., New York, N. Y.

WANTED

3 or 4 stage gas compressor approximately 50 cubic feet per minute capacity; motor drive. Will consider steam or gas engine. Wire or phone

W. A. Delaney, Jr., Ada, Okla.

For Sale—Equipment

FOR SALE—One complete steam rotary outfit less boilers, located near Coyle, Oklahoma, priced to sell. Inquire T. T. Eason and Company, Enid, Okla.

FOR SALE: 1—40 ft. diam. 25 ft. high storage tank and 1—31 ft. diam. and 25 ft. high, 1—25 ft. in diam., 20 ft. high. Ed Walsh, P.O. Box 143, Marion, Indiana.

SURPLUS OIL EQUIPMENT

Tanks — Trucks — Trailers — Meters — River Barges — Compressors — Money — Safes — Gasoline Pumps — Oil Stoves — Flood Lights — Office Machines.
FELDMAN PETROLEUM COMPANY
544 W. Roosevelt Rd., Chicago, Ill.

For Sale—Equipment

TANKS FOR SALE

220,000 gal. 43' x 20' Steel Tank. 1—14,000 gal. and 2—11,000 gal. and 1—8,000 gal. Steel Tanks. 12—9' x 8' Wood Tanks 2—10,500 bbl. 50' x 30' steel tanks with steel roofs.

L. M. STANHOPE
Wayne, Penna.

2—120 HP, 650 RPM, rebuilt Diesel engines, power units.
1—200 HP, 514 RPM, completely rebuilt Diesel engine, power unit.
The two above can be supplied with Generators if desired.
2—66 HP Boilers.
1—75 HP variable speed A.C. motor.
Also variable sizes small alternating current motors.

K. S. RICHARDS
P.O. Box 443, Fort Worth, Texas
Phone 3-5600

FOR SALE: 4—5¾ & 6¾ x 12 Airline Slush Pumps; good condition; very reasonable. W. J. Perlitz, 2720 Bernhardt Drive, Phone 6978, Port Arthur, Texas.

1 COOPER-Bessemer 3 cylinder engine Type G M R size 12" x 14", 225 HP direct connected to Cooper-Bessemer Compressor, high side 12" x 14", low side 6½" x 14". Excellent condition. Box B-291, The Oil and Gas Journal, Tulsa, Okla.

TWO vertical type Askania Magnetometers. Also one complete Heiland resistivity outfit. Write Box B-285, The Oil and Gas Journal, Tulsa, Okla.

FOR SALE — A large stock of reconditioned valves and fittings suitable for refinery and pipe line service. Inquire Eason Oil Company, Enid, Okla.

FOR SALE at Oklahoma City: Ten 70-HP, 175# WP, F & T, LFB used reconditioned boilers. Cities Service Oil, Patridge, Bartlesville, Okla.

⅞" Oklahoma City used sucker rods, 50,000 feet, good condition. 50—10 and 12" x 23' Channels. 3—24" x 20' Beams and some short pieces, smaller sizes. Some reinforcing sucker rods, all at Oklahoma City. M. R. Travis, 1702 S Boulder, Tulsa, Okla.

FOR SALE — 135 ft. ¾" x 4" woven Brake Lining. Jack Monroe, 2919½ S. Catalina St., Los Angeles, Calif.

FOR SALE

1—A. O. Smith Corporation hammered forged reaction chamber 4 ft. by 40 ft. 4 in. thick.
1—Crude Oil Fractionator tower, 5 ft. by 74 ft., 4000 barrels a day capacity—½ inch steel shell single girth riveted, welded collar manholes.
1—lot of 3 and 4 inch O.D. key headers also some 3 and 4 inch O.D. tubing.

REFINERY ENGINEERING CO.
Forest Park, Ill.

FOR SALE

1—Imperial Type 10. 10"x4½"x10" compressor with 100 H.P. G.E. motor, skid mounted.
1 each—3'x10', 5'x15', 7'x24' separators, standard pressure.
1—15 H.P. F & M Gas Engine.
1—3'x7' scrubber tank.
Miscellaneous group of valves and fittings 3" up.
1—Model 47 F & M oil engine, skid-mounted, complete with fuel tank.
Vaughn S. Bryan Phone 4-4111
Kennedy Bldg. Tulsa, Okla.

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3 Lines	$1.05	$1.80	$2.55	$3.30	7 Lines	$2.45	$4.20	$5.95	$7.70
4 Lines	1.40	2.40	3.40	4.40	8 Lines	2.80	4.80	6.80	8.80
5 Lines	1.75	3.00	4.25	5.50	9 Lines	3.15	5.40	7.65	9.90
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Tulsa, Oklahoma

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18 heat exchangers. Over 50 tanks from 250 barrels to 25,000 barrels included. Car load Ethyl plant. Latest type of equipment offered for sale by any refinery.

Location: Titan Oil Co., Stark, Mich. (Detroit suburb) For sale in its entirety, parts or will lease in its entirety. Have complete Universal Oil Company's inspection report, together with all blue prints.

Notice—Give us a list of your surplus equipment, especially valves and fittings

SONKEN-GALAMBA SUPPLY COMPANY

W. C. Berry or H. J. Galamba
Riverside at Second, Kansas City, Kansas

Robert W. Duden
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CASING—DERRICKS—TUBING

We have several thousand feet of used 6⅝" casing, 2" tubing and ⅝" sucker rods. Also several pipe pumping derricks for sale cheap. Condition good.

HARLAND OIL CO.
Wolco, Okla. Phone Barnsdall 14F22

FOR SALE: Star machine with tools, 5" to 10" complete. Would consider working on same, or anything pertaining to the oil field. Have had years of experience handling production. D. G. Minesinger, 308 North Street, Iola, Kansas.

FOR SALE: 1—110 h.p. twin, direct drive Miller Compressor with 6½x20 compressor cylinder complete, now operating—$975.00. Wayne O. Watts, First Nat'l. Bank Bldg., Breckenridge, Tex.

FOR SALE AT BARGAIN—1 complete rotary rig with Cardwell R.L. double drum drawworks and 7½x12 G.D. Pump, 160 HP Engines. Box 1439, Tulsa, Okla.

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25 K.W. and 40 K.W. Gas Engines, 220 volts, D.C. Two 100 K.W. Gas Engine-Generator Sets, 220 volts, D.C. 7x6 Ingersoll-Rand ER-1 Air Compressor. Six-inch Oster Pipe Threading Machine. Also large stock of lathes, pipe machines, milling machines, etc. Send for our list.

Terms to suit.

CINCINNATI MACHINERY & SUPPLY CO.
26 West 2nd St., Cincinnati, Ohio.

FOR SALE: 40,000 ft. reconditioned Reda Cable. Specifications #2, 3 conductor, rubber insulated, armor covered, electric transmission cable. Part excellent for use in oil wells, other good for various electric conduction. Leonard Smith, 1526 N.E. 19th St. Ph. 5-0841, Oklahoma City, Okla.

FOR SALE: 27½" Ideal Rotary Table, 5 sheave 200 ton Crown Block, 4 sheave 72" traveling block, 8" Ideal enclosed rotary hook. Melton Machinery & Supply Co., Seminole, Okla.

DIESEL—GAS—ENGINES

Large selection—All sizes and types. Generator units, marine engines, gasoline engines, auxiliaries—boilers, steam engines, and turbo-generator sets.

Complete information on request.

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48 Church Street, New York, N. Y.

FOR SALE: Star Mfg. Company, portable cooling tower, telescoping type, 7' wide, 13' long, 8' high. All steel. Melton Machinery & Supply Co., Seminole, Okla.

FOR SALE—Approx. 6500 ft. 6⅝" OD 25.20# drill pipe with Reed Full Hole Shrink Grip Tool Joints, A-1 condition. Inquire T. T. Eason and Company, Enid, Okla.

FOR SALE: Complete Wilson Portable Rotary Rig with telescoping mast, suitable for 2,000 ft. drilling. Melton Machinery & Supply Co., Seminole, Okla.

FOR SALE: 1—18' band wheel power; 6 No. 3 OK jacks complete and one 1500 watt Kohler plant; also, drilling bits stems and jars, Butler County, Kansas. Box B-366, The Oil and Gas Journal, Tulsa, Okla.

FOR SALE—One partial list steam rotary equipment less boilers, rotary table, traveling block, swivel, located near Coyle, Oklahoma, priced right to sell. Inquire T. T. Eason and Company, Enid, Okla.

Reconditioned, Tested and Guaranteed Gate Valves for sale, Large stock, sizes 16" to 2", flanged end and screw end. various pressures.

Stock List and Prices on Request.

THE GATE VALVE SHOP
120 Tuke Box 1936
Pampa, Texas

FOR SALE: Pipe tongs, various sizes from 3" to 20". Box B-371, The Oil and Gas Journal, Tulsa, Okla.

FOR SALE—Three 15 x 10 and one 12 x 10 Pneumatic Compressors less motors or power units. In excellent condition, suitable for low pressure service. Inquire Eason Oil Company, Enid, Okla.

FOR SALE—COMPLETE KELLOGG PLANT

4,000 barrel Kellogg 2-coil Cracking and Vis-Breaking Unit equipped with 1,000 barrel asphalt vacuum tower.
4—Turbine driven hot oil pumps.
3—Simplex steel cylinder pumps.
1—two-stage steam driven duplex charge pump.
2—brand new Kellogg heat exchangers, never been used.
Complete set of control instruments.
Original cost over $750,000.00. Will sell in its entirety, $195,000.00. This unit has been reserved to be re-erected at another location. Blueprints and complete data available.

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Phone 5-0324 1601 Columbia Mutual Tower Bldg.
MEMPHIS, TENNESSEE

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FOR SALE: 7¼ x 14 Oil Well Power Slush Pump. Melton Machinery & Supply Co., Seminole, Okla.

FOR SALE—Two Cardwell model RL double drum well servicing units with spudder attachments complete with wire lines, light plants, cable tools and tool houses. Melton Machinery & Supply Co., Seminole, Okla.

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Used Engines, Compressors, Power Plants and Gasoline Plant Equipment.

We Rebuild and Guarantee

L. F. SMITH CO.

217 W. Archer, Tulsa, Okla.

SPECIAL OFFER
IMMEDIATE SHIPMENT

OXYGEN-ACETYLENE WELDING HOSE SETS

Guaranteed—Heavy Duty
Standard Size—Double Braid

Samples furnished on request

Each set consists of OXYGEN hose (BLACK) and ACETYLENE hose (RED) with standard brass couplings attached to fit all makes of torches and gauges.

Length set	*Price per set*
12½ Ft. set	$ 3.10
25 Ft. set	5.60
50 Ft. set	10.60
75 Ft. set	15.60
100 Ft. set	20.60
Connector set	.30

Hose also furnished in continuous length reels of approximately 250 ft. and 500 ft. lengths.

OXYGEN HOSE	10c per ft.
ACETYLENE HOSE	10c per ft.
STANDARD COUPLINGS	15c each

Prices net—F.O.B. New York

CARLYLE RUBBER CO., Inc.
62 Park Place New York, N. Y.

Used Gasoline Pumps May Be Installed on Farms

WASHINGTON, D. C.—Used gasoline dispensing pumps may be installed on farms of 10 acres or more if legal title to the equipment is held by the farm owner or operator, under Amendment 3 to Conservation Order M-68-c, issued last week by the War Production Board.

The amendment is designed to prohibit indiscriminate lending of equipment to farmers, it was explained.

In permitting the installation of pumps and tanks on farms of 10 acres or more, the amendment provides that the equipment to be installed must be second-hand and must have been completely fabricated on or before January 14, 1942. Also, the pumps and storage tanks must be installed exclusively for dispensing petroleum products to machinery and vehicles used directly in operations on the individual farm.

Legal title to the equipment cannot be held by the supplier of the equipment, and no restrictions, either oral or written, can be made whereby the use of the equipment is limited to dispensing the products of any supplier or group of suppliers.

One of the main points of the order is that fuel-oil tanks and pumps used to dispense fuel oil may be installed hereafter only for the purpose of dispensing into the tanks of *stationary* facilities. Their installation for the purpose of supplying petroleum to tractors and other mobile equipment thus is brought under the same ban which already applies in the case of gasoline tanks.

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Journalisms:

WHEN possible war hazards are added to the normal danger of fire around oil storage, an article on the subject is particularly timely. When the article is prepared by a man with the experience of John D. McCamey, it adds authority to timeliness. Captain McCamey's article, "Combating Fires in Oil Storage Tanks" is scheduled for next week's issue of the Journal.

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JOHN D. McCAMEY, Carter Oil Co. safety engineer, was born in Sistersville, W. Va., October 28, 1898. After finishing grammar and high school at Sistersville, he worked for Carter in West Virginia as a trainee from April 1917 to September 1918. He then enlisted in the S.A.T.C., serving during the first World War from September until December 1918, and returning to Carter as a roustabout.

In 1920 McCamey resumed his education in the School of Mines at the University of Pittsburgh, graduating in 1926 with an engineer of mining degree. Following graduation he worked as an engineer for Petroleum Exploration, Inc., and the Wiser Oil Co.

In 1932, McCamey accepted a contract with International Petroleum Co., Ltd., and was sent to Negritos, Peru, South America, as a petroleum foreman, completing this contract in 1935. He then came to Tulsa to accept a position with Carter as safety engineer, a responsibility he has held until recently.

During his years as safety engineer for Carter Mr. McCamey has been vitally interested in industrial safety progress and has served in various capacities in this connection. He has been chairman of the industrial section of the Tulsa Safety Council; chairman of the Mid-Continent Petroleum Safety Council and the Mid-Continent section of the National Safety Council, a member of the central safety committee of the A.P.I.; a member of the advisory committee to the central safety committee of the A.P.I.; chairman of the technical subcommittee to the committee on safety regulations, Oklahoma-Kansas division of the Mid-Continent Oil and Gas Association; and a member of the A.P.I. committee on standardization of oil-field boilers.

Mr. McCamey has been commissioned a captain in the U. S. Army and reported for active duty at Camp Claiborne, Louisiana, November 12, 1942.

CALENDAR

November

AMERICAN CHEMICAL SOCIETY, national chemical exposition and national industrial chemical conference, Sherman Hotel, Chicago, Ill., November 24-29.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, annual meeting, New York, November 30-December 4.

December

NEW MEXICO OIL AND GAS ASSOCIATION, annual meeting, Artesia Hotel, Artesia, N. M., December 2.

PETROLEUM ACCOUNTANTS SOCIETY OF OKLAHOMA, Hotel Mayo, Tulsa, December 17.

INTERSTATE OIL COMPACT COMMISSION, annual organization meeting, Biltmore Hotel, Oklahoma City, Okla., December 18-19.

1943

February

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS, New York, February 15-18, 1943.

April

AMERICAN PETROLEUM INSTITUTE, Division of Production, Eastern district, William Penn Hotel, Pittsburgh, Pa., April 8-9, 1943.

AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS, annual meeting, Fort Worth, Tex., April 7-9.

May

PETROLEUM INDUSTRY ELECTRICAL ASSOCIATION, annual meeting, Houston, Tex., May 5-6, 1943.